



## **DEPARTMENT OF THE INTERIOR**

### **Fish and Wildlife Service**

#### **50 CFR Part 17**

**[Docket No. FWS– R8–ES–2012–0100]**

**[4500030113]**

**RIN 1018–AZ21**

**Endangered and Threatened Wildlife and Plants; Endangered Species Status for Sierra Nevada Yellow-Legged Frog and Northern Distinct Population Segment of the Mountain Yellow-Legged Frog, and Threatened Species Status for Yosemite Toad**

**AGENCY:** Fish and Wildlife Service, Interior.

**ACTION:** Final rule.

**SUMMARY:** We, the U.S. Fish and Wildlife Service (Service), determine endangered species status under the Endangered Species Act of 1973 (Act), as amended, for the

Sierra Nevada yellow-legged frog and the northern distinct population segment (DPS) of the mountain yellow-legged frog (mountain yellow-legged frog populations that occur north of the Tehachapi Mountains), and determine threatened species status under the Act for the Yosemite toad. The effect of this regulation will be to add these species to the List of Endangered and Threatened Wildlife.

**DATES:** This rule becomes effective [INSERT DATE 60 DAYS AFTER DATE OF PUBLICATION IN THE FEDERAL REGISTER].

**ADDRESSES:** This final rule is available on the Internet at <http://www.regulations.gov> and at the Sacramento Fish and Wildlife Office. Comments and materials we received, as well as supporting documentation used in preparing this rule, are available for public inspection at <http://www.regulations.gov>. All of the comments, materials, and documentation that we considered in this rulemaking are available by appointment, during normal business hours at: U.S. Fish and Wildlife Service, Sacramento Fish and Wildlife Office, 2800 Cottage Way, Room W-2605, Sacramento, CA, 95825; 916-414-6600 (telephone); 916-414-6712 (facsimile).

**FOR FURTHER INFORMATION CONTACT:** Jennifer Norris, Field Supervisor, U.S. Fish and Wildlife Service, Sacramento Fish and Wildlife Office, 2800 Cottage Way, Room W-2605, Sacramento, CA, 95825; 916-414-6600 (telephone); 916-414-6712 (facsimile). Persons who use a telecommunications device for the deaf (TDD) may call the Federal Information Relay Service (FIRS) at 800-877-8339.

## **SUPPLEMENTARY INFORMATION:**

### **Executive Summary**

*Why we need to publish a rule.* Under the Endangered Species Act, a species may warrant protection through listing if it is endangered or threatened throughout all or a significant portion of its range. Listing a species as an endangered or threatened species can be only completed by issuing a rule.

*This rule will* finalize the listing of the Sierra Nevada yellow-legged frog (*Rana sierrae*) as an endangered species, the northern DPS of the mountain yellow-legged frog (*Rana muscosa*) as an endangered species, and the Yosemite toad (*Anaxyrus canorus*) as a threatened species.

*The basis for our action.* Under the Endangered Species Act, we can determine that a species is an endangered or threatened species based on any of five factors: (A) The present or threatened destruction, modification, or curtailment of its habitat or range; (B) Overutilization for commercial, recreational, scientific, or educational purposes; (C) Disease or predation; (D) The inadequacy of existing regulatory mechanisms; or (E) Other natural or manmade factors affecting its continued existence.

We have determined that both the Sierra Nevada yellow-legged frog and the northern DPS of the mountain yellow-legged frog are presently in danger of extinction

throughout their entire ranges, based on the immediacy, severity, and scope of the threats to their continued existence. These include habitat degradation and fragmentation, predation and disease, climate change, inadequate regulatory protections, and the interaction of these various stressors impacting small remnant populations. A rangewide reduction in abundance and geographic extent of surviving populations of frogs has occurred following decades of fish stocking, habitat fragmentation, and most recently a disease epidemic. Surviving populations are smaller and more isolated, and recruitment in diseased populations is much reduced relative to historic norms. This combination of population stressors makes persistence of these species precarious throughout the currently occupied range in the Sierra Nevada.

We have also determined that the Yosemite toad is likely to become endangered throughout its range within the foreseeable future, based on the immediacy, severity, and scope of the threats to its continued existence. These include habitat loss associated with degradation of meadow hydrology following stream incision consequent to the cumulative effects of historical land management activities, notably livestock grazing, and also the anticipated hydrologic effects upon habitat from climate change. We also find that the Yosemite toad is likely to become endangered through the direct effects of climate change impacting small remnant populations, likely compounded with the cumulative effect of other threat factors (such as disease).

*Peer review and public comment.* We sought comments from independent specialists to ensure that our designations are based on scientifically sound data, assumptions, and

analyses. We invited these peer reviewers to comment on our listing proposal. We also considered all comments and information received during the comment period.

### **Previous Federal Actions**

Please refer to the proposed listing rule for the Sierra Nevada yellow-legged frog, the northern DPS of the mountain yellow-legged frog, and the Yosemite toad (78 FR 24472, April 25, 2013) for a detailed description of previous Federal actions concerning these species.

We will also be finalizing critical habitat designations for the Sierra Nevada yellow-legged frog, the northern DPS of the mountain yellow-legged, and the Yosemite toad under the Act in the near future.

### **Summary of Biological Status and Threats for the Sierra Nevada Yellow-Legged Frog and the Northern DPS of the Mountain Yellow-Legged Frog**

### **Background**

Please refer to the proposed listing rule for the Sierra Nevada yellow-legged frog and the northern DPS of the mountain yellow-legged frog under the Act (16 U.S.C. 1531 *et seq.*) for additional species information. In the proposed rule, we described two separate species of yellow-legged frogs, *Rana sierrae* and *Rana muscosa*, that resulted

from the recent taxonomic split (see **Taxonomy** section below) of the previously known *Rana muscosa*, which we referred to in our proposed rule as the mountain yellow-legged frog “species complex.” For clarity and in order to maintain consistency with our previous treatment of the southern DPS of the mountain yellow-legged frog in southern California (67 FR 44382, July 2, 2002) as well as with our proposed rule, and for the purposes of this document, we retain the common name of mountain yellow-legged frog for *Rana muscosa*, as opposed to the new common name, southern mountain yellow-legged frog, as published by Crother *et al.* (2008, p. 11). We also note that the California Department of Fish and Game (CDFG) was recently renamed the California Department of Fish and Wildlife (CDFW). We refer to the California Department of Fish and Wildlife in all cases when discussing the agency in the text. Where citations are from CDFG documents, we include CDFW in parentheses for clarification.

## Taxonomy

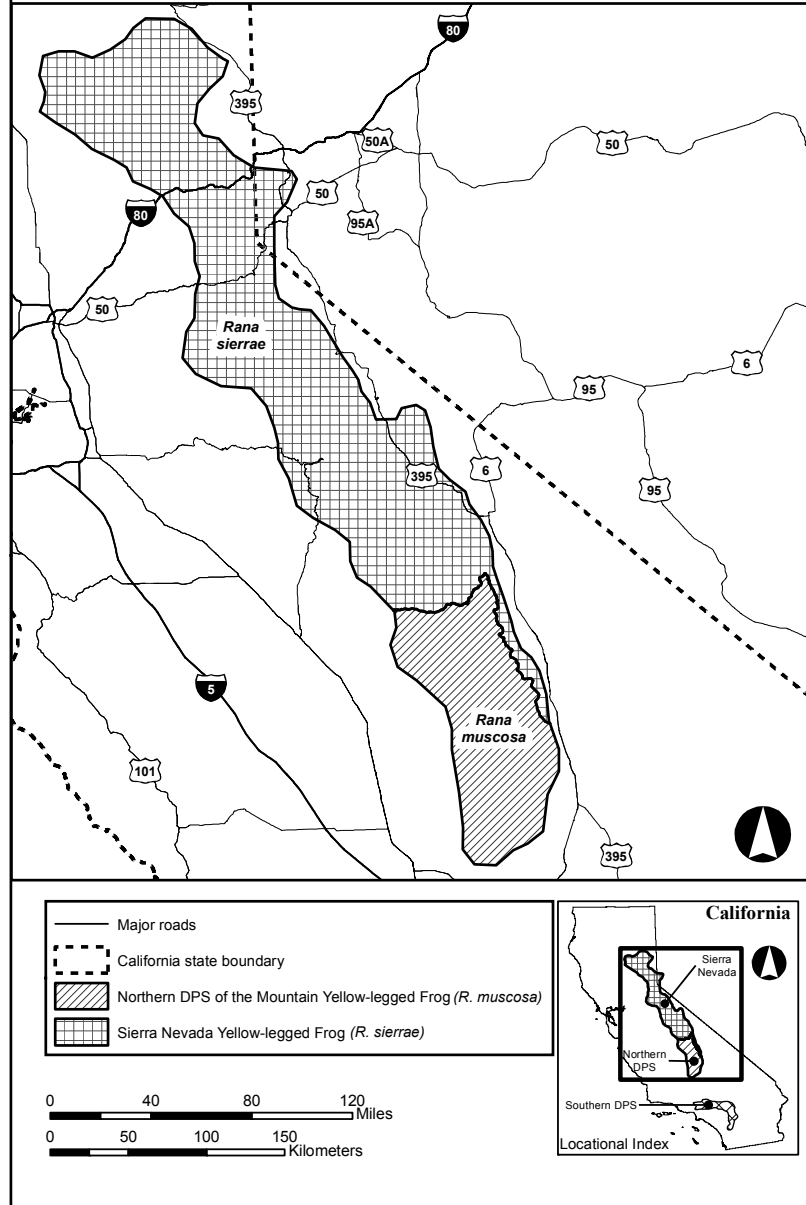
Please refer to the proposed listing rule for the Sierra Nevada yellow-legged frog and the northern DPS of the mountain yellow-legged frog under the Act (16 U.S.C. 1531 *et seq.*) for detailed species information on taxonomy (78 FR 24472, April 25, 2013).

Vredenburg *et al.* (2007, p. 371) determined that *Rana sierrae* occurs in the Sierra Nevada north of the South Fork Kings River watershed, along the east slope of the Sierra Nevada south into Inyo County at the southern extent of its range, and in the Glass Mountains just south of Mono Lake; and that *R. muscosa* occurs in the southern portion

of the Sierra Nevada within and south of the South Fork Kings River watershed to the west of the Sierra Nevada crest (along with those populations inhabiting southern California) (Vredenburg *et al.* 2007, pp. 370–371). The Monarch Divide separates these species in the western Sierra Nevada, while they are separated by the Cirque Crest to the east (Knapp 2013, unpaginated).

For purposes of this rule, we recognize the species differentiation as presented in Vredenburg *et al.* (2007, p. 371) and adopted by the official societies mentioned above (Crother *et al.* 2008, p. 11), and in this final rule we refer to *Rana sierrae* as the Sierra Nevada yellow-legged frog, and we refer to the Sierra Nevada populations of *R. muscosa* as the northern DPS of the mountain yellow-legged frog. In California and Nevada, the Sierra Nevada yellow-legged frogs occupy the western Sierra Nevada north of the Monarch Divide (in Fresno County) and the eastern slope of the Sierra Nevada (east of the crest) from Inyo County through Mono County (including the Glass Mountains), to areas north of Lake Tahoe. The northern DPS of the mountain yellow-legged frog occurs only in California in the western Sierra Nevada and extends from south of the Monarch Divide in Fresno County through portions of the Kern River drainage. Figure 1 shows the approximate species boundaries within their historical ranges as determined by Knapp (unpubl. data).

**Figure 1**  
**Estimated Historical Range of Sierra Nevada Yellow-legged Frog**  
**and Northern DPS of the Mountain Yellow-legged Frog**





Many studies cited in the rest of this document include articles and reports that were published prior to the official species reclassification, where the researchers may reference either one or both species. Where possible and appropriate, information will be referenced specifically (either as Sierra Nevada yellow-legged frog or the northern DPS of the mountain yellow-legged frog) to reflect the split of the species. Where information applies to both species, the two species will be referred to collectively as mountain yellow-legged frog or mountain yellow-legged frog species complex.

## Species Description

Please refer to the proposed listing rule for the Sierra Nevada yellow-legged frog and the northern DPS of the mountain yellow-legged frog under the Act (16 U.S.C. 1531 *et seq.*) for additional information about species descriptions (78 FR 24472, April 25, 2013). The body lengths (snout to vent) of the mountain yellow-legged frogs range from 40 to 80 millimeters (mm) (1.5 to 3.25 inches (in)) (Jennings and Hayes 1994, p. 74). Females average slightly larger than males, and males have a swollen, darkened thumb base (Wright and Wright 1949, pp. 424–430; Stebbins 1951, pp. 330–335; Zweifel 1955, p. 235; Zweifel 1968, p. 65.1). Dorsal (upper) coloration in adults is variable, exhibiting a mix of brown and yellow, but also can be grey, red, or green-brown, and is usually patterned with dark spots (Jennings and Hayes 1994, p. 74; Stebbins 2003, p. 233). These spots may be large (6 mm (0.25 in)) and few, smaller and more numerous, or a mixture of both (Zweifel 1955, p. 230). Irregular lichen- or moss-like patches (to which

the name *muscosa* refers) may also be present on the dorsal surface (Zweifel 1955, pp. 230, 235; Stebbins 2003, p. 233).

The belly and undersurfaces of the hind limbs are yellow or orange, and this pigmentation may extend forward from the abdomen to the forelimbs (Wright and Wright 1949, pp. 424–429; Stebbins 2003, p. 233). Mountain yellow-legged frogs may produce a distinctive mink or garlic-like odor when disturbed (Wright and Wright 1949, p. 432; Stebbins 2003, p. 233). Although these species lack vocal sacs, they can vocalize in or out of water, producing what has been described as a faint clicking sound (Zweifel 1955, p. 234; Ziesmer 1997, pp. 46–47; Stebbins 2003, p. 233). Mountain yellow-legged frogs have smoother skin, generally with heavier spotting and mottling dorsally, darker toe tips (Zweifel 1955, p. 234), and more opaque ventral coloration (Stebbins 2003, p. 233) than the foothill yellow-legged frog.

The Sierra Nevada yellow-legged frog and the northern DPS of the mountain yellow-legged frog are similar morphologically and behaviorally (hence their shared taxonomic designation until recently). However, these two species can be distinguished from each other physically by the ratio of the lower leg (fibulotibia) length to snout vent length. The northern DPS of the mountain yellow-legged frog has longer limbs (Vredenburg *et al.* 2007, p. 368). Typically, this ratio is greater than or equal to 0.55 in the northern DPS of the mountain yellow-legged frog and less than 0.55 in the Sierra Nevada yellow-legged frog.

Mountain yellow-legged frogs deposit their eggs in globular clumps, which are often somewhat flattened and roughly 2.5 to 5 centimeters (cm) (1 to 2 in) in diameter (Stebbins 2003, p. 444). When eggs are close to hatching, egg mass volume averages 198 cubic cm (78 cubic in) (Pope 1999, p. 30). Eggs have three firm, jelly-like, transparent envelopes surrounding a grey-tan or black vitelline (egg yolk) capsule (Wright and Wright 1949, pp. 431–433). Clutch size varies from 15 to 350 eggs per egg mass (Livezey and Wright 1945, p. 703; Vredenburg *et al.* 2005, p. 565). Egg development is temperature dependent. In laboratory breeding experiments, egg hatching time ranged from 18 to 21 days at temperatures of 5 to 13.5 degrees Celsius (°C) (41 to 56 degrees Fahrenheit (°F)) (Zweifel 1955, pp. 262–264). Field observations show similar results (Pope 1999, p. 31).

The tadpoles of mountain yellow-legged frogs generally are mottled brown on the dorsal side with a faintly yellow venter (underside) (Zweifel 1955, p. 231; Stebbins 2003, p. 460). Total tadpole length reaches 72 mm (2.8 in), the body is flattened, and the tail musculature is wide (about 2.5 cm (1 in) or more) before tapering into a rounded tip (Wright and Wright 1949, p. 431). The mouth has a maximum of eight labial (lip) tooth rows (two to four upper and four lower) (Stebbins 2003, p. 460). Tadpoles may take more than 1 year (Wright and Wright 1949, p. 431), and often require 2 to 4 years, to reach metamorphosis (transformation from tadpoles to frogs) (Cory 1962b, p. 515; Bradford 1983, pp. 1171, 1182; Bradford *et al.* 1993, p. 883; Knapp and Matthews 2000, p. 435), depending on local climate conditions and site-specific variables.

The time required to reach reproductive maturity in mountain yellow-legged frogs is thought to vary between 3 and 4 years post metamorphosis (Zweifel 1955, p. 254). This information, in combination with the extended amount of time as a tadpole before metamorphosis, means that it may take 5 to 8 years for mountain yellow-legged frogs to begin reproducing. While the typical lifespan of mountain yellow-legged frogs is largely unknown, Matthews and Miaud (2007, p. 991) estimated that the total lifespan (including tadpole and adult life stages) ranges up to 14 years, with other documented estimates of up to 16 years of age for the Sierra Nevada yellow-legged frog (Fellers *et al.* 2013, p. 155), suggesting that mountain yellow-legged frogs are long-lived amphibians.

#### Habitat and Life History

Mountain yellow-legged frogs currently exist in montane regions of the Sierra Nevada of California. Throughout their range, these species historically inhabited lakes, ponds, marshes, meadows, and streams at elevations typically ranging from 1,370 to 3,660 meters (m) (4,500 to 12,000 feet (ft)) (CDFG (CDFW)) 2011, pp. A-1–A-5), but can occur as low as 1,067 m (3,500 ft) in the northern portions of their range (USFS 2011, geospatial data; USFS 2013, p. 4). Mountain yellow-legged frogs are highly aquatic; they are generally not found more than 1 m (3.3 ft) from water (Stebbins 1951, p. 340; Mullally and Cunningham 1956a, p. 191; Bradford *et al.* 1993, p. 886). Mullally and Cunningham (1956a, p. 191) found adults sitting on rocks along the shoreline, where there was little or no vegetation. Although mountain yellow-legged frogs may use a variety of shoreline habitats, both tadpoles and adults are observed less frequently at

shorelines that drop abruptly to a depth of 60 cm (2 ft) than at open shorelines that gently slope up to shallow waters of only 5 to 8 cm (2 to 3 in) in depth (Mullally and Cunningham 1956a, p. 191; Jennings and Hayes 1994, p. 77).

At lower elevations within their historical range, these species have been associated with rocky streambeds and wet meadows surrounded by coniferous forest (Zweifel 1955, p. 237; Zeiner *et al.* 1988, p. 88), although, in general, little is known about the ecology of mountain yellow-legged frogs in Sierra Nevada stream habitats (Brown 2013, unpaginated). Zweifel (1955, p. 237) found that streams utilized by adults varied from streams having high gradients and numerous pools, rapids, and small waterfalls, to streams with low gradients and slow flows, marshy edges, and sod banks, while aquatic substrates varied from bedrock to fine sand, rubble (rock fragments), and boulders. Jennings and Hayes (1994, p. 77) have indicated that mountain yellow-legged frogs appear absent from the smallest creeks, and suggest that it is probably because these creeks have insufficient depth for adequate refuge and overwintering habitat. However, Brown (2013, unpaginated) reports that the frogs are found in small creeks, although she notes that the extent to which these are remnant populations now excluded from preferred habitat is not known. In the northern portion of the Sierra Nevada yellow-legged frog range, the remnant populations primarily occur in stream habitats.

At higher elevations, these species occupy lakes, ponds, tarns (small steep-banked mountain lakes or pools, generally of glacial origin), and streams (Zweifel 1955, p. 237; Mullally and Cunningham 1956a, p. 191). Mountain yellow-legged frogs in the Sierra

Nevada are most abundant in high-elevation lakes and slow-moving portions of streams (Zweifel 1955, p. 237; Mullally and Cunningham 1956a, p. 191). The borders of alpine (above the tree line) lakes and mountain meadow streams used by mountain yellow-legged frogs are frequently grassy or muddy, although many are bordered by exposed glaciated bedrock. Zweifel (1955, pp. 237–238) suggested that alpine lakeshores differ from the sandy or rocky shores inhabited by mountain yellow-legged frogs in lower elevation streams.

Adult mountain yellow-legged frogs breed in a variety of habitats including the shallows of stillwater habitat (lakes or ponds) and flowing inlet streams (Zweifel 1955, p. 243; Pope 1999, p. 30). Adults emerge from overwintering sites immediately following snowmelt, and will even move over ice to reach breeding sites (Pope 1999, pp. 46–47; Vredenburg *et al.* 2005, p. 565). Mountain yellow-legged frogs deposit their eggs underwater in clusters, which they attach to rocks, gravel, or vegetation, or which they deposit under banks (Wright and Wright 1949, p. 431; Stebbins 1951, p. 341; Zweifel 1955, p. 243; Pope 1999, p. 30).

Lake depth is an important attribute defining habitat suitability for mountain yellow-legged frogs. At high elevations, both frogs and tadpoles overwinter under ice in lakes and streams. As tadpoles must overwinter multiple years before metamorphosis, successful breeding sites are located in (or connected to) lakes and ponds that do not dry out in the summer, and also are deep enough that they do not completely freeze or become oxygen-depleted (anoxic) in winter. Both adults and tadpole mountain yellow-

legged frogs overwinter for up to 9 months in the bottoms of lakes that are at least 1.7 m (5.6 ft) deep; however, overwinter survival may be greater in lakes that are at least 2.5 m (8.2 ft) deep (Bradford 1983, p. 1179; Vredenburg *et al.* 2005, p. 565).

Bradford (1983, pp. 1173, 1178–1179) found that, in years with exceptional precipitation (61 percent above average) and greater than normal ice-depths, mountain yellow-legged frog die-offs sometimes result from oxygen depletion during winter in lakes less than 4 m (13 ft) in depth, finding that in ice-covered lakes, oxygen depletion occurs most rapidly in shallow lakes relative to deeper lakes. However, tadpoles may survive for months in nearly anoxic conditions when shallow lakes are frozen to the bottom. More recent work reported populations of mountain yellow-legged frogs overwintering in lakes less than 1.5 m (5 ft) deep that were assumed to have frozen to the bottom, and yet healthy frogs emerged the following July (Matthews and Pope 1999, pp. 622–623; Pope 1999, pp. 42–43). Matthews and Pope 1999, p. 619) used radio telemetry to find that, when lakes had begun to freeze over, the frogs were utilizing rock crevices, holes, and ledges near shore, where water depths ranged from 0.2 m (0.7 ft) to 1.5 m (5 ft). Vredenburg *et al.* (2005, p. 565) noted that such behavior may be a response to presence of introduced fish. Matthews and Pope (1999, p. 622) suggested that the granite surrounding these overwintering habitats probably insulates mountain yellow-legged frogs from extreme winter temperatures, and that they can survive, provided there is an adequate supply of oxygen.

Mountain yellow-legged frog tadpoles maintain a relatively high body temperature by selecting warmer microhabitats (Bradford 1984, p. 973). During winter, tadpoles remain in warmer water below the thermocline (the transition layer between thermally stratified water). After spring overturn (thaw and thermal mixing of the water), they behaviorally modulate their body temperature by moving to shallow, near-shore water when warmer days raise surface water temperatures. During the late afternoon and evening, mountain yellow-legged frogs retreat to offshore waters that are less subject to night cooling (Bradford 1984, p. 974).

Available evidence suggests that adult mountain yellow-legged frogs display strong site fidelity and return to the same overwintering and summer habitats from year to year (Pope 1999, p. 45; Matthews and Preisler 2010, p. 252). Matthews and Pope (1999, pp. 618–623) observed that the frogs' movement patterns and habitat associations shifted seasonally. Frogs were well-distributed in most lakes, ponds, and creeks during August, but moved to only a few lakes by October. Matthews and Pope (1999, pp. 618–623) established home-range areas for 10 frogs and found that frogs remained through August in the lake or creek where they'd been captured, with movement confined to areas ranging from 19.4 to 1,028 square meters ( $\text{m}^2$ ) (23.20 to 1,229 square yards ( $\text{y}^2$ )). In September, movements increased, with home-ranges varying from 53 to 9,807  $\text{m}^2$  in size (63.4 to 11,729  $\text{y}^2$ ); six of nine frogs tagged in September moved from that lake by the end of the month, suggesting a pattern in which adult mountain yellow-legged frogs move among overwintering, breeding, and feeding sites during the year, with narrow distributions in early spring and late fall due to restricted overwintering habitat (Pope and



Matthews 2001, p. 791). Although terrestrial movements of more than two or three hops from water were previously undocumented, overland movements exceeding 66 m (217 ft) were observed in 17 percent of tagged frogs, demonstrating that mountain yellow-legged frogs move overland as well as along aquatic pathways (Pope and Matthews 2001, p. 791). Pope and Matthews (2001, p. 791) also recorded a movement distance of over 1 km (including a minimum of 420 m (0.26 miles) overland movement and movement through a stream course). The farthest reported distance of a mountain yellow-legged frog from water is 400 m (1,300 ft) (Vredenburg 2002, p. 4).

Within stream systems, Sierra Nevada yellow-legged frogs have been documented to move 1,032 m (3,385 ft) over a 29-day period (Fellers *et al.* 2013, p. 159). Wengert (2008, p. 18) conducted a telemetry study that documented single-season movement distances for Sierra Nevada yellow-legged frog of up to 3.3 kilometers (km) (2.05 miles (mi)) along streams. Along stream habitats, adults have been observed greater than 22 m (71 ft) from the water during the overwintering period (Wengert 2008, p. 20). Additionally, during the duration of the study, Wengert (2008, p. 13) found that 14 percent of the documented frog locations occurred greater than 0.2 m (0.66 ft) from the stream edge. While recent information suggests that the frogs in the Wengert study may have actually been foothill yellow-legged frog (*Rana boylei*) (Poorten *et al.*, 2013, p. 4), we expect that the movement distances recorded are applicable to the Sierra Nevada yellow-legged frog within a stream-based system, as the ecology is comparable between the two sister taxa in regard to stream systems.

Almost no data exist on the dispersal of juvenile mountain yellow-legged frogs away from breeding sites; however, juveniles that may be dispersing have been observed in small intermittent streams (Bradford 1991, p. 176). Regionally, mountain yellow-legged frogs are thought to exhibit a metapopulation structure (Bradford *et al.* 1993, p. 886; Drost and Fellers 1996, p. 424). Metapopulations are spatially separated population subunits within migratory distance of one another such that individuals may interbreed among subunits and populations may become reestablished if they are extirpated (Hanski and Simberloff 1997, p. 6).

#### Historical Range and Distribution

Mountain yellow-legged frogs were historically abundant and ubiquitous across many of the higher elevations within the Sierra Nevada. Grinnell and Storer (1924, p. 664) reported the Sierra Nevada yellow-legged frog to be the most common amphibian surveyed in the Yosemite area. It is difficult to know the precise historical ranges of the Sierra Nevada yellow-legged frog and the northern DPS of the mountain yellow-legged frog, because projections must be inferred from museum collections that do not reflect systematic surveys, and survey information predating significant rangewide reduction is very limited. However, projections of historical ranges are available using predictive habitat modeling based on recent research (Knapp, unpubl. data).

Historically, the range of the Sierra Nevada yellow-legged frog extended in California from north of the Feather River, in Butte and Plumas Counties, south to the

Monarch Divide on the west side of the Sierra Nevada crest in Fresno County. East of the Sierra Nevada crest in California, the historical range of the Sierra Nevada yellow-legged frog extends from areas north of Lake Tahoe, through Mono County (including the Glass Mountains) to Inyo County. Historical records indicate that the Sierra Nevada yellow-legged frog also occurred at locations within the Carson Range of Nevada, including Mount Rose in Washoe County, and also occurred in the vicinity of Lake Tahoe in Douglas County, Nevada (Linsdale 1940, pp. 208–210; Zweifel 1955, p. 231; Jennings 1984, p. 52; Knapp 2013, unpaginated).

Historically, the northern DPS of the mountain yellow-legged frog ranged from the Monarch Divide in Fresno County as far southward as Breckenridge Mountain, in Kern County (Vredenburg *et al.* 2007, p. 371). The historical ranges of the two frog species within the mountain yellow-legged complex, therefore, meet each other roughly along the Monarch Divide to the north, and along the crest of the Sierra Nevada to the east. Because we have determined that the historic range of *R. muscosa* is entirely within the State of California, in this final rule we correct the listing for the southern DPS of the mountain yellow-legged frog to remove Nevada from its historic range.

#### Current Range and Distribution

Since the time of the mountain yellow-legged frog observations of Grinnell and Storer (1924, pp. 664–665), a number of researchers have reported disappearances of these species from a large fraction of their historical ranges in the Sierra Nevada (Hayes

and Jennings 1986, p. 490; Bradford 1989, p. 775; Bradford *et al.* 1994, pp. 323–327; Jennings and Hayes 1994, p. 78; Jennings 1995, p. 133; Stebbins and Cohen 1995, pp. 225–226; Drost and Fellers 1996, p. 414; Jennings 1996, pp. 934–935; Knapp and Matthews 2000, p. 428; Vredenburg *et al.* 2005, p. 564).

The current distributions of the Sierra Nevada yellow-legged frog and the northern DPS of the mountain yellow-legged frog are restricted primarily to publicly managed lands at high elevations, including streams, lakes, ponds, and meadow wetlands located within National Forests and National Parks. National Forests with extant (surviving) populations of mountain yellow-legged frogs include the Plumas National Forest, Tahoe National Forest, Humboldt-Toiyabe National Forest, Lake Tahoe Basin Management Unit, Eldorado National Forest, Stanislaus National Forest, Sierra National Forest, Sequoia National Forest, and Inyo National Forest. National Parks with extant populations of mountain yellow-legged frogs include Yosemite National Park, Kings Canyon National Park, and Sequoia National Park.

The most pronounced declines within the mountain yellow-legged frog complex have occurred north of Lake Tahoe in the northernmost 125-km (78-mi) portion of the range (Sierra Nevada yellow-legged frog) and south of Kings Canyon National Park in Tulare County (the northern DPS of the mountain yellow-legged frog). In the southernmost 50-km (31-mi) portion of the range, only a few populations of the northern DPS of the mountain yellow-legged frog remain (Fellers 1994, p. 5; Jennings and Hayes 1994, pp. 74–78); except for a few small populations in the Kern River drainage, the

northern DPS of the mountain yellow-legged frog is entirely extirpated from all of Sequoia National Park (Knapp 2013, unpaginated). As of 2000, mountain yellow-legged frog populations were known to have persisted in greater density in the National Parks of the Sierra Nevada as compared to the surrounding U.S. Forest Service (USFS) lands, and the populations that did occur in the National Parks generally exhibited higher abundances than those on USFS lands (Bradford *et al.* 1994, p. 323; Knapp and Matthews 2000, p. 430).

### Population Estimates and Status

Monitoring efforts and research studies have documented substantial declines of mountain yellow-legged frog populations in the Sierra Nevada. The number of extant populations has declined greatly over the last few decades. Remaining populations are patchily scattered throughout the historical range (Jennings and Hayes 1994, pp. 74–78; Jennings 1995, p. 133; Jennings 1996, p. 936). In the northernmost portion of the range (Butte and Plumas Counties), only a few Sierra Nevada yellow-legged frog populations have been documented since 1970 (Jennings and Hayes 1994, pp. 74–78; CDFG (CDFW) *et al.*, unpubl. data). Declines of both species have also been noted in the central and southern Sierra Nevada (Drost and Fellers 1996, p. 420; Knapp and Matthews 2001, pp. 433–437; Knapp 2013, unpaginated). In the southern Sierra Nevada (Sierra, Sequoia, and Inyo National Forests; and Kings Canyon and Yosemite National Parks), modest to relatively large populations (for example, breeding populations of approximately 40 to more than 200 adults) of mountain yellow-legged frogs do remain; however, in recent

years some large populations have been extirpated in this area (Bradford 1991, p. 176; Bradford *et al.* 1994, pp. 325–326; Knapp 2002a, p. 10, Wake and Vredenburg 2009, pp. 11467–11470).

Davidson *et al.* (2002, p. 1591) reviewed 255 previously documented mountain yellow-legged frog locations (based on Jennings and Hayes 1994, pp. 74–78) throughout the historical range and concluded that 83 percent of these sites no longer support frog populations. Vredenburg *et al.* (2007, pp. 369–371) compared recent survey records (1995–2004) with museum records from 1899–1994 and reported that 92.5 percent of historical Sierra Nevada yellow-legged frog populations and 92.3 percent of populations of the northern DPS of mountain yellow-legged frog are now extirpated.

CDFW (CDFG (CDFW) 2011, pp. 17–20) used historical localities from museum records covering the same time interval (1899–1994), but updated recent locality information with additional survey data (1995–2010) to significantly increase proportional coverage from the Vredenburg *et al.* (2007) study. These more recent surveys failed to detect any extant frog populations (within 1 km (0.63 mi), a metric used to capture interbreeding individuals within metapopulations) at 220 of 318 historical Sierra Nevada yellow-legged frog localities and 94 of 109 historical northern DPS of the mountain yellow-legged frog localities (in the Sierran portion of their range). This calculates to an estimated loss of 69 percent of Sierra Nevada yellow-legged frog metapopulations and 86 percent of northern DPS of the mountain yellow-legged frog metapopulations from historical occurrences.

In addition to comparisons based on individual localities, CDFW (CDFG 2011, pp. 20–25) compared historical and recent population status at the watershed scale. This is a rough index of the geographic extent of the species through their respective ranges. Within the Sierra Nevada, 44 percent of watersheds historically utilized by Sierra Nevada yellow-legged frogs, and 59 percent of watersheds historically utilized by northern DPS mountain yellow-legged frogs, no longer support extant populations. However, this watershed-level survey methodology is not a good indicator of population changes because a watershed is counted as recently occupied if a single individual (at any life stage) is observed within the entire watershed even though several individual populations may have been lost (CDFG (CDFW) 2011b, p. 20). Therefore, these surveys likely underestimate population declines. Many watersheds support only a single extant metapopulation, which occupies one to several adjacent water bodies (CDFG (CDFW) 2011, p. 20). Remaining populations are generally very small.

Rangewide, declines of mountain yellow-legged frog populations were estimated at around one-half of historical populations by the end of the 1980s (Bradford *et al.* 1994, p. 323). Between 1988 and 1991, Bradford *et al.* (1994a, pp. 323–327) resurveyed sites known historically (1955 through 1979 surveys) to support mountain yellow-legged frogs. They did not detect frogs at 27 historical sites on the Kaweah River, and they detected frogs at 52 percent of historical sites within Sequoia and Kings Canyon National Parks and 12.5 percent of historical sites outside of Sequoia and Kings Canyon National Parks. Because this work was completed before the taxonomic division of mountain

yellow-legged frogs, we have not differentiated between the two species here. When both species are combined, this resurvey effort detected mountain yellow-legged frogs at 19.4 percent of historical sites (Bradford *et al.* 1994, pp. 324–325).

Available information discussed below indicates that the rates of population decline have not abated, and they have likely accelerated during the 1990s into the 2000s. Drost and Fellers (1996, p. 417) repeated Grinnell and Storer's early 20<sup>th</sup> century surveys in Yosemite National Park, and reported frog presence at 2 of 14 historical sites where what is now known as Sierra Nevada yellow-legged frogs occurred. The two positive sightings consisted of a single tadpole at one site and a single adult female at another. They identified 17 additional sites with suitable mountain yellow-legged frog habitat, and in those surveys, they detected 3 additional populations. In 2002, Knapp (2002a, p. 10) resurveyed 302 water bodies known to be occupied by mountain yellow-legged frogs between 1995 and 1997, and 744 sites where frogs were not previously detected. Knapp found frogs at 59 percent of the previously occupied sites, whereas 8 percent of previously unoccupied sites were colonized. These data suggest an extirpation rate five to six times higher than the colonization rate within this study area. The documented extirpations appeared to occur non-randomly across the landscape, were typically spatially clumped, and involved the disappearance of all or nearly all of the mountain yellow-legged frog populations in a watershed (Knapp 2002a, p. 9). CDFW (CDFG 2011, p. 20) assessed data from sites where multiple surveys were completed after 1995 (at least 5 years apart). They found that the Sierra Nevada yellow-legged frog was not detected at 45 percent of sites where they previously had been confirmed, while the



mountain yellow-legged frog (rangewide, including southern California) was no longer detectable at 81 percent of historically occupied sites.

The USFS has been conducting a rangewide, long-term monitoring program for the Sierra Nevada yellow-legged frog and the northern DPS of the mountain yellow-legged frog on National Forest lands in the Sierra Nevada, known as the Sierra Nevada Amphibian Monitoring Program (SNAMPH). This monitoring effort provides unbiased estimates by using an integrated unequal probability design, and it provides numbers for robust statistical comparisons across 5-year monitoring cycles spanning 208 watersheds (Brown *et al.* 2011, pp. 3–4). The results of this assessment indicate that the species have declined in both distribution and abundance. Based on surveys conducted from 2002 through 2009, breeding activity was found in about half (48 percent) of the watersheds where the species were found in the decade prior to SNAMPH monitoring (1990 and 2001) (Brown *et al.* 2011, p. 4). Breeding was found in 3 percent of watersheds where species had been found prior to 1990. Rangewide, breeding was found in 4 percent of watersheds. Moreover, relative abundances were low; an estimated 9 percent of populations were large (numbering more than 100 frogs or 500 tadpoles); about 90 percent of the watersheds had fewer than 10 adults, while 80 percent had fewer than 10 subadults and 100 tadpoles (Brown *et al.* 2011, p. 24).

To summarize population trends over the available historical record, estimates range from losses between 69 to 93 percent of Sierra Nevada yellow-legged frog populations and 86 to 92 percent of the northern DPS of the mountain yellow-legged

frog. Rangewide reduction has diminished the number of watersheds that support mountain yellow-legged frogs somewhere between the conservative estimates of 44 percent in the case of Sierra Nevada yellow-legged frogs and at least 59 percent in the case of the northern DPS of the mountain yellow-legged frogs, to as high as 97 percent of watersheds for the mountain yellow-legged frog complex across the Sierra Nevada. Remaining populations are much smaller than historical norms, and the density of populations per watershed has declined substantially; as a result, many watersheds currently support single metapopulations at low abundances.

### **Distinct Vertebrate Population Segment Analysis**

Under the Act, we must consider for listing any species, subspecies, or, for vertebrates, any DPS of these taxa if there is sufficient information to indicate that such action may be warranted. To implement the measures prescribed by the Act, we, along with the National Marine Fisheries Service (National Oceanic and Atmospheric Administration–Fisheries), developed a joint policy that addresses the recognition of DPSs for potential listing actions (61 FR 4722). The policy allows for a more refined application of the Act that better reflects the biological needs of the taxon being considered and avoids the inclusion of entities that do not require the Act’s protective measures.

Under our DPS policy, three elements are considered in a decision regarding the status of a possible DPS as endangered or threatened under the Act. The elements are:

(1) Discreteness of the population segment in relation to the remainder of the species to which it belongs; (2) the significance of the population segment to the species to which it belongs; and (3) the population segment's conservation status in relation to the Act's standards for listing. In other words, if we determine that a population segment of a vertebrate species being considered for listing is both discrete and significant, we would conclude that it represents a DPS, and thus a "species" under section 3(16) of the Act, whereupon we would evaluate the level of threat to the DPS based on the five listing factors established under section 4(a)(1) of the Act to determine whether listing the DPS as an "endangered species" or a "threatened species" is warranted.

Please refer to the proposed listing rule for detailed information about the distinct vertebrate population segment analysis for the northern DPS of the mountain yellow-legged frog (78 FR 24472, April 25, 2013). We previously confirmed the status of the southern California population of the mountain yellow-legged frog as a DPS at the time that it was listed as endangered under the Act (67 FR 44382, pp. 44384–44385). We summarize below the analysis for discreteness and significance for the northern California population of the mountain yellow-legged frog (in the Sierra Nevada); this summary includes changes from the proposed rule to address comments received from the public (78 FR 24472, April 25, 2013).

#### *Discreteness*

Under our DPS Policy, a population segment of a vertebrate species may be considered discrete if it satisfies either of the following two conditions: (1) It is markedly separated from other populations of the same taxon as a consequence of physical, physiological, ecological, or behavioral factors (quantitative measures of genetic or morphological discontinuity may provide evidence of this separation); or (2) it is delimited by international governmental boundaries within which significant differences in control of exploitation, management of habitat, conservation, status, or regulatory mechanisms exist.

The analysis of the northern population segment of the mountain yellow-legged frog (*Rana muscosa*) (in the Sierra Nevada) is based on the marked separation from other populations. The range of the mountain yellow-legged frog is divided by a natural geographic barrier, the Tehachapi Mountains, which physically isolates the populations in the southern Sierra Nevada from those in the mountains of southern California. The distance of the geographic separation is about 225 km (140 mi). The geographic separation of the Sierra Nevada and southern California frogs was recognized in the earliest description of the species by Camp (1917), who treated frogs from the two areas as separate subspecies within the *R. boylei* group (see more on classification of the mountain yellow-legged frogs in Taxonomy). There is no contiguous habitat that provides connectivity between the two populations that is sufficient for the migration, growth, rearing, or reproduction of dispersing frogs. Genetic differences well-supported in the scientific literature also provide evidence of this separation (see Taxonomy).

Therefore, we find that the northern population segment of the mountain yellow-legged frog (*Rana muscosa*) (in the Sierra Nevada) is discrete from the remainder of the species.

### *Significance*

Under our DPS Policy, once we have determined that a population segment is discrete, we consider its biological and ecological significance to the larger taxon to which it belongs. Our DPS policy provides several potential considerations that may demonstrate the significance of a population segment to the remainder of its taxon, including: (1) evidence of the persistence of the discrete population segment in an ecological setting unusual or unique for the taxon, (2) evidence that loss of the discrete population segment would result in a significant gap in the range of the taxon, (3) evidence that the population segment represents the only surviving natural occurrence of a taxon that may be more abundant elsewhere as an introduced population outside its historic range, or (4) evidence that the discrete population segment differs markedly from the remainder of the species in its genetic characteristics.

We have found substantial evidence that three of the four significance criteria are met by the discrete northern population segment of the mountain yellow-legged frog that occurs in the Sierra Nevada. These include its persistence in an ecological setting that is unique for the taxon, evidence that its loss would result in a significant gap in the range of the taxon, and its genetic uniqueness (reflecting significant reproductive isolation over time). To establish the significance of the discrete northern population segment, we rely

on the effect that the loss of this population segment would have on the range of the taxon, and supplement that with evidence that the population segment persists in an ecological setting unusual or unique for the taxon and also differs from other population segments in its genetic characteristics. There are no introduced populations of the northern DPS of the mountain yellow-legged frog outside of the species' historical range.

Evidence indicates that loss of the northern population segment of the mountain yellow-legged frog (in the Sierra Nevada) would result in a significant gap in the range of the taxon. The Sierran mountain yellow-legged frogs comprise the entire distribution of the species in approximately the northern half of the species' range, and loss of the distinct population segment in the northern portion of the range could have significant conservation implications for the species. Furthermore, loss of the northern population segment of the mountain yellow-legged frog (in the Sierra Nevada) would reduce the species to the remaining small, isolated sites in the streams of southern California (USFWS, Jul 2012, pp. 11–12). Loss of the northern population segment of the mountain yellow-legged frog would leave an area of the southern Sierra Nevada over 150 km (93 mi) in length without any ranid (frogs in the genus *Ranidae*) frogs, which were once abundant and widespread in the higher elevation Sierra Nevada (Cory 1962b, p. 515; Fellers 1994, p. 5). The potential loss of the northern population segment of the mountain yellow-legged frog would constitute a significant gap in the range of the species.

One of the most striking differences between the northern population segment and the southern population segment of the mountain yellow-legged frogs is the difference in the ecological setting in which they each persist. Zweifel (1955, pp. 237–241) observed that the frogs in southern California are typically found in steep-gradient streams in the chaparral belt at low elevations (370 m (1,220 ft)), even though they may range into small meadow streams at higher elevations up to 2,290 m (7,560 ft). In contrast, frogs from the northern population segment of mountain yellow-legged frogs are most abundant in high-elevation lakes and slow-moving portions of streams where winter conditions are extreme. David Bradford's (1989) southern Sierra Nevada study of mountain yellow-legged frogs, for example, was conducted in Sequoia and Kings Canyon National Parks at high elevations between 2,910 and 3,430 m (9,600 to 11,319 ft). The rugged canyons of the arid mountain ranges of southern California, where waters seldom freeze, bear little resemblance to the alpine lakes and streams of the Sierra Nevada where adult frogs and tadpoles must overwinter at the bottoms of ice and snow-covered lakes for up to 9 months of the year. The significantly different ecological settings between mountain yellow-legged frogs in southern California and those in the northern population segment (in the Sierra Nevada) distinguish these populations from each other.

Finally, the northern population segment of the mountain yellow-legged frog is biologically significant based on genetic differences. Vredenburg *et al.* (2007, p. 361) identified that two of three distinct genetic clades (groups of distinct lineage) constitute the northern range of the mountain yellow-legged frog found in the Sierra Nevada, with the remaining clade represented by the endangered southern California DPS of the

mountain yellow-legged frog. Macey *et al.* (2001, p. 141) estimated the genetic divergence between the northern population of mountain yellow-legged frogs (in the Sierra Nevada) and the southern population of mountain yellow-legged frogs (in southern California) to have occurred 1.4 million years before present (mybp), thereby indicating functional isolation.

The loss of the northern population of the mountain yellow-legged frog would result in a significant gap in the range of the mountain yellow-legged frog species. The differences between the ecological settings for the southern population of mountain yellow-legged frogs (steep-gradient streams that seldom freeze) and the northern population of mountain yellow-legged frogs (high-elevation lakes and slow-moving portions of streams where frogs overwinter under ice and snow for up to 75 percent of the year) are significant. Additionally, the genetic distinction between these two populations reflects isolation for over a million years. Therefore based on the information discussed above, we find that northern population of the mountain yellow-legged frog (in the Sierra Nevada mountains) meets the significance criteria under our Policy Regarding the Recognition of Distinct Vertebrate Population Segments (61 FR 4722).

#### DPS Conclusion

Based on the best scientific and commercial data available on distribution as well as ecological setting and genetic characteristics of the species, we have determined that the northern population segment of the mountain yellow-legged frog (in the Sierra



Nevada) is both discrete and significant per our DPS policy. Therefore, we conclude that the northern discrete population segment of the mountain yellow-legged frog is a DPS, and thus a “species” under section 3(16) of the Act. Our determination of biological and ecological significance is appropriate because the population segment has a geographical distribution that is biologically meaningful.

### **Summary of Changes from the Proposed Rule for the Sierra Nevada Yellow-Legged Frog and the Northern DPS of the Mountain Yellow-Legged Frog**

Based on peer review, Federal and State, and public comments (see comments in the **Summary of Comments and Recommendations** section below), we have clarified information in the sections provided for the Sierra Nevada yellow-legged frog and the northern DPS of the mountain yellow-legged frog to better characterize our knowledge of the species’ habitat requirements, correcting some information based on peer review (vocalizations (Species Description), species ranges (Taxonomy and Historic and Current Ranges and Distribution sections), current distribution in Sequoia National Park (Historic and Current Ranges and Distribution), and clarifying the basis for our determination of significance for the northern population of the mountain yellow-legged frog in response to public comments (Distinct Vertebrate Population Segment)), occasionally adding additional information where needed. In the **Summary of Factors Affecting the Species** section, we have re-ordered threats in Factor A so that the primary activity that has modified the habitat of the mountain yellow-legged frog complex is addressed first, while activities with potential only for localized effects are addressed later. Based on peer

review, and Federal, State, county, and public comments, we have added information where needed and clarified our findings on the role of current activities, such as grazing, recreation, packstock use, etc., in species declines. We reviewed the analysis of dams and diversions that we presented in the proposed rule and determined that most large reservoir facilities are below the current range of the mountain yellow-legged frogs. We revised the dams and water diversions threat magnitude from moderate prevalent in the proposed rule to minor localized where such structures occur in this final rule.

In the proposed rule, we stated that grazing presented a minor prevalent threat. We reworded this final rule to more accurately reflect the contribution of legacy effects of past grazing levels to this threat assessment. We found that current livestock grazing that complies with forest standards and guidelines is not expected to negatively affect mountain yellow-legged frog populations in most cases, although limited exceptions could occur (where extant habitat is limited and legacy effects to meadows still require restoration, where habitat is limited such as in stream riparian zones or small meadows, or where grazing standards are exceeded). Rangewide, livestock grazing is not a substantial threat to the species.

In response to information provided during the public comment period, we added a discussion of mining activities in the Factor A discussion. In this final rule, we determine that, while most mining activities take place below the extant ranges of the species, where some types of mining activities occur, localized habitat-related effects may result.

We added new information available on packstock grazing, retaining our finding that packstock grazing is only likely to be a threat to mountain yellow-legged frogs in limited situations. We also added more information on roads and timber harvests, and we clarified that these activities primarily do not occur where there are extant populations (except where frogs occur in the northern or lower elevation portions of the range), and that USFS standards are generally designed to limit potential effects of such activities. We clarified the threat magnitude for roads and timber harvest from minor prevalence rangewide to not a threat to extant populations across much of the species' ranges (although they may pose important habitat-related effects to the species in localized areas). We reviewed information provided by the U.S. Forest Service (USFS), the National Park Service (NPS), CDFW, and others on recreation activities, and we changed our conclusion on the recreation threat magnitude from low significance to the species overall to not considered a threat to populations over much of their range. However, we recognize that there may be localized effects, especially outside of backcountry areas where use is high or where motorized and mechanical use occurs in extant frog habitat.

We added a brief discussion of bullfrogs (*Lithobates catesbeiana*) under Factor C for mountain yellow-legged frogs noting that bullfrog predation and competition is expected to have population-level effects to mountain yellow-legged frog populations in those low elevation areas, or in the Lake Tahoe Basin, where the two species may co-occur. We slightly revised our characterization of the recent population declines of the mountain yellow-legged frogs due to *Batrachochytrium dendrobatidis* (Bd), identifying

the fungus as one of the primary drivers of recent declines, and adding information provided by peer reviewers and agencies. We also added information to our discussion under Factor D, including information about the National Park Service Organic Act, information on the provision in the Wilderness Act about withdrawing minerals, and information on the status of the Sierra Nevada yellow-legged frog and the mountain yellow-legged frog under the California Endangered Species Act (CESA). We also moved discussion of current CDFW fisheries management to the “Habitat Modification Due to Introduction of Trout to Historically Fishless Areas” section under Factor A.

We removed the discussion of contaminants under Factor E and refer readers to the proposed rule. Although we received additional information that clarified some text and provided additional references regarding contaminants, the clarifications supported our conclusions in the proposed rule that the best available information indicates that contaminants do not pose a current or continuing threat to the species. We also added additional information either available in our files, or provided by commenters, to clarify and support our finding on the threat of climate change. We revised the explanation in the determinations for each species to reflect the above changes.

### **Summary of Factors Affecting the Species**

Section 4 of the Act (16 U.S.C. 1533), and its implementing regulations at 50 CFR part 424, set forth the procedures for adding species to the Federal Lists of Endangered and Threatened Wildlife and Plants. Under section 4(a)(1) of the Act, we

may list a species based on any of the following five factors: (A) The present or threatened destruction, modification, or curtailment of its habitat or range; (B) overutilization for commercial, recreational, scientific, or educational purposes; (C) disease or predation; (D) the inadequacy of existing regulatory mechanisms; and (E) other natural or manmade factors affecting its continued existence. Listing actions may be warranted based on any of the above threat factors, singly or in combination. Each of these factors is discussed below, and changes from the proposed rule (78 FR 24472, April 25, 2013) are reflected in these discussions. The following analysis is applicable to both the Sierra Nevada yellow-legged frog (*Rana sierrae*) and the northern distinct population segment of the mountain yellow-legged frog (*Rana muscosa*).

*Factor A. The Present or Threatened Destruction, Modification, or Curtailment of Its Habitat or Range*

A number of hypotheses, including habitat modification (including loss of vegetation, loss of wetlands, habitat modification for urban development, and degradation of upland habitats) have been proposed for recent global amphibian declines (Bradford *et al.* 1993, p. 883; Corn 1994, p. 62; Alford and Richards 1999, p. 134). However, physical habitat modification has not been associated with the rangewide decline of mountain yellow-legged frogs. Mountain yellow-legged frogs occur primarily at high elevations in the Sierra Nevada, which have not had the types or extent of large-scale habitat conversion and physical disturbance that have occurred at lower elevations (Knapp and Matthews 2000, p. 429). Thus, direct habitat destruction or modification

associated with intensive human activities has not been implicated in the decline of this species (Davidson *et al.* 2002, p. 1597).

However, other human activities may have played a role in the modification of mountain yellow-legged frog habitat. We have identified the following habitat-related activities as potentially relevant to the conservation status of the mountain yellow-legged frog complex: Fish introductions (see also Factor C, below), dams and water diversions, livestock grazing, timber management, road construction and maintenance, packstock use, recreational activities, and fire management activities. Such activities may have degraded habitat in ways that have reduced its capacity to sustain viable populations and may have fragmented and isolated mountain yellow-legged frog populations from each other.

#### Habitat Modification Due to Introduction of Trout to Historically Fishless Areas

One habitat feature that is documented to have a significant detrimental impact to mountain yellow-legged frog populations is the presence of introduced trout resulting from stocking programs for the creation and maintenance of a recreational fishery. To further angling success and opportunity, trout stocking programs in the Sierra Nevada started in the late 19<sup>th</sup> century (Bahls 1992, p. 185; Pister 2001, p. 280). This anthropogenic activity has community-level effects and is one of the primary threats to mountain yellow-legged frog habitat and species viability.

Prior to extensive trout planting programs, almost all streams and lakes in the Sierra Nevada at elevations above 1,800 m (6,000 ft) were fishless. Several native fish species occur naturally in aquatic habitats below this elevation in the Sierra Nevada (Knapp 1996, pp. 12–14; Moyle *et al.* 1996, p. 354; Moyle 2002, p. 25), but natural barriers prevented fish from colonizing the higher-elevation waters of the Sierra Nevada watershed (Moyle *et al.* 1996, p. 354). The upper reaches of the Kern River, where native fish such as the Little Kern golden trout (*Oncorhynchus mykiss whitei*) and California golden trout (*O. m. aguabonita*) evolved, represent the only major exception to the 1,800-m (6,000-ft) elevation limit for fishes within the range of the mountain yellow-legged frog in the Sierra Nevada (Moyle 2002, p. 25). Additionally, prior to extensive planting, native Paiute cutthroat (*O. clarki seleneris*) and Lahontan cutthroat (*O. c. henshawi*) were limited in their distribution to several rivers, streams, and limited large lakes in the eastern Sierra Nevada (Knapp 1996, p. 369; Moyle 1996 *et al.*, pp. 954–958), indicating some overlap with the range of the Sierra Nevada yellow-legged frog.

Some of the first practitioners of trout stocking in the Sierra Nevada were the Sierra Club, local sportsmen's clubs, private citizens, and the U.S. military (Knapp 1996, p. 8; Pister 2001, p. 280). As more hatcheries were built and the management of the trout fishery became better organized, fish planting continued for the purpose of increased angler opportunities and success (Pister 2001, p. 281). After World War II, the method of transporting trout to high-elevation areas changed from packstock to aircraft, which allowed stocking in more remote lakes and in greater numbers. With the advent of aerial stocking, trout planting expanded to new areas, with higher efficiency.

Brook trout (*Salvelinus fontinalis*), brown trout (*Salmo trutta*), rainbow trout (*Oncorhynchus mykiss*), and other trout species assemblages have been planted in most streams and lakes of the Sierra Nevada (Knapp 1996, p. 8; Moyle 2002, p. 25). Since the advent of aerial stocking, backcountry areas not accessible by truck are stocked by air (Pert 2002, pers. comm.), which limits stocking to lakes. National Forests in the Sierra Nevada have a higher proportion of lakes with fish occupancy than do National Parks (Knapp 1996, p. 3), primarily because the National Park Service (NPS) began phasing out fish stocking within their jurisdictional boundaries in 1969, with limited stocking occurring until it was terminated altogether in Sierra Nevada National Parks in 1991 (Knapp 1996, p. 9). California Department of Fish and Wildlife (CDFW) continues to stock trout in National Forest water bodies, but in 2001 reduced the number of stocked water bodies to reduce impacts to native amphibians (ICF Jones & Stokes 2010, pp. ES-1–ES-16). Current stocking decisions are based on criteria outlined in the Environmental Impact Report for the Hatchery and Stocking Program (ICF Jones & Stokes 2010, Appendix K).

Fish stocking as a practice has been widespread throughout the range of both species of mountain yellow-legged frogs. Knapp and Matthews (2000, p. 428) indicated that 65 percent of the water bodies that were 1 ha (2.5 ac) or larger in National Forests they studied were stocked with fish on a regular basis. Over 90 percent of the total water body surface area in the John Muir Wilderness was occupied by nonnative trout (Knapp and Matthews 2000, p. 434).



Another detrimental feature of fish stocking is that, in the Sierra Nevada, fish often persist in water bodies even after stocking ceases. Thirty-five to 50 percent of lakes larger than 1 ha (2.5 ac) within Sierra Nevada National Parks are occupied by nonnative fish, which is only a 29 to 44 percent decrease in fish occupancy since fish stocking was terminated around 2 decades before the estimate was made (Knapp 1996, p. 1). Though data on fish occupancy in streams are lacking throughout the Sierra Nevada, Knapp (1996, pp. 9–11) estimated that 60 percent of the streams in Yosemite National Park were still occupied by introduced trout because trout readily move out of lakes to colonize both inlet and outlet streams. The presence of trout in these once fishless waters has modified the habitat at a landscape scale.

Thus, the frog's habitat has been modified due to the introduction of a nonnative predator that both competes for limited food resources and directly preys on mountain yellow-legged frog tadpoles and adults (see Factor C below). Presence of nonnative trout in naturally fishless ecosystems has had profound effects on the structure and composition of faunal assemblages, severely reducing not only amphibians, but also zooplankton and large invertebrate species (see Knapp 1996, p. 6; Bradford *et al.* 1998, p. 2489; Finlay and Vredenburg 2007, pp. 2194–2197). Within the frog's historical range, past trout introductions and the continuing presence of fish in most lakes resulted in the elimination of frogs from most waters that were suitable for fish. Across the range of these species in the Sierra Nevada, the presence of fish in most of the deeper lakes has altered the aquatic habitat that mountain yellow-legged frogs rely on for overwintering

and breeding, and has also reduced connectivity among frog populations. Fish now populate the deeper lakes and connecting streams and largely separate and increase the distance between the current sites inhabited by the highly-aquatic frogs (the connectivity of occupied sites in present versus former fishless conditions differs by approximately 10-fold) (Bradford *et al.* 1993, pp. 884–887; Knapp 1996, pp. 373–379). Where reservoirs harbor introduced fish, successful reproduction of mountain yellow-legged frogs may be reduced if there are no shallow side channels or separate pools (Jennings 1996, p. 939). Most reservoirs do not overlap significantly with the current extant range of the species (CDFW 2013, p. 3) (see Dams and Water Diversions below); however, a number of reservoirs were constructed in the mid-1900s at mid-elevations within lower edges of the species' historic range (for example, Sierra Nevada yellow-legged frogs were taken from Bear River Reservoir (Eldorado National Forest), Union Reservoir (Stanislaus National Forest), and several others). With the exception of one 1999 record from Faggs Reservoir on the Plumas National Forest, all of several dozen records of the species from reservoirs are pre-1975, and at least half pre-date the water development projects at those locations (Brown *et al.* 2009, p. 78). All of these reservoirs now harbor introduced fish species, and at least two also harbor bullfrogs, suggesting that subsequent introductions may have played a role in past declines in those areas (see Brown *et al.* 2009, p. 78).

The body of scientific research has demonstrated that introduced trout have negatively impacted mountain yellow-legged frogs over much of the Sierra Nevada (Grinnell and Storer 1924, p. 664; Bradford 1989, pp. 775–778; Bradford *et al.* 1993, pp.

882–888; Knapp 1994, p. 3; Drost and Fellers 1996, p. 422; Knapp 1996, pp. 13–15; Bradford *et al.* 1998, pp. 2482, 2489; Knapp and Matthews 2000, p. 428; Knapp *et al.* 2001, p. 401). Fish stocking programs have negative ecological implications because fish eat aquatic fauna, including amphibians and invertebrates (Bahls 1992, p. 191; Erman 1996, p. 992; Jennings 1996, p. 939; Knapp 1996, pp. 373–379; Matthews *et al.* 2001, pp. 1135–1136; Pilliod and Peterson 2001, p. 329; Schindler *et al.* 2001, p. 309; Moyle 2002, p. 58; Epanchin *et al.* 2010, p. 2406). Finlay and Vredenburg (2007, p. 2187) documented that the same benthic (bottom-dwelling) invertebrate resource base sustains the growth of both frogs and trout, suggesting that competition with trout for prey is an important factor that may contribute to the decline of the mountain yellow-legged frog. Introductions of salmonids to fishless lakes have also been associated with alteration of nutrient cycles and primary productivity in mountain lakes, including those in the Sierra Nevada (Schindler *et al.* 2001, pp. 308, 313–319).

Knapp and Matthews (2000, p. 428) surveyed more than 1,700 water bodies, and concluded that a strong negative correlation exists between introduced trout and mountain yellow-legged frogs (Knapp and Matthews 2000, p. 435). Consistent with this finding are the results of an analysis of the distribution of mountain yellow-legged frog tadpoles, which indicate that the presence and abundance of this life stage are reduced dramatically in fish-stocked lakes (Knapp *et al.* 2001, p. 408). Knapp (2005a, pp. 265–279) also compared the distribution of nonnative trout with the distributions of several amphibian and reptile species in 2,239 lakes and ponds in Yosemite National Park, and found that mountain yellow-legged frogs were five times less likely to be detected in

waters where trout were present. Even though stocking within the National Park ceased in 1991, more than 50 percent of water bodies deeper than 4 m (13 ft) and 75 percent deeper than 16 m (52 ft) still contained trout populations in 2000–2002 (Knapp 2005a, p. 270). Both trout and mountain yellow-legged frogs utilize deeper water bodies. Based on the results from Knapp (2005a), the reduced detection of frogs in trout-occupied waters indicates that trout are excluding mountain yellow-legged frogs from some of the best aquatic habitat.

Several aspects of the mountain yellow-legged frog's life history are thought to exacerbate its vulnerability to extirpation by trout (Bradford 1989, pp. 777–778; Bradford *et al.* 1993, pp. 886–888; Knapp 1996, p. 14; Knapp and Matthews 2000, p. 435). Mountain yellow-legged frogs are highly aquatic and are found primarily in lakes, most of which now contain trout (Knapp 1996, p. 14). In comparison to other Sierran frogs, mountain yellow-legged frog tadpoles generally need at least 2 years to reach metamorphosis, which restricts breeding to waters that are deep enough to avoid depletion of oxygen when ice-covered (Knapp 1996, p.14). Overwintering adults must also avoid oxygen depletion when the water is covered by ice, generally limiting overwintering to deeper waters that do not become anoxic (Mullally and Cunningham 1956a, p. 194; Bradford 1983, p. 1179; Knapp and Matthews 2000, pp. 435–436). At high elevations, both tadpoles and adults overwinter under ice for up to 9 months (Bradford 1983, p. 1171). These habitat requirements appear to restrict successful breeding and overwintering to the deeper water bodies where the chances of summer drying and winter freezing are reduced, the same water bodies that are most suitable for

fishes; fishes also need deeper water bodies where the chances of summer drying and winter freezing are reduced (Bradford 1983, pp. 1172–1179; Knapp 1996, p. 14; Knapp and Matthews 2000, pp. 429, 435–436). Past fish-stocking practices targeted the deeper lakes, so the percentage of water bodies containing fish has increased with water depth, resulting in elimination of mountain yellow-legged frogs from once suitable habitats in which they were historically most common, and thereby generally isolating populations to the shallower, marginal habitats that do not have fish (Bradford 1983, pp. 1172–1179; Bradford *et al.* 1993, pp. 884, 886–887; Knapp and Matthews 2000, pp. 435–436).

Mountain yellow-legged frogs and trout (native and nonnative) do co-occur at some sites, but these co-occurrences are generally thought to represent mountain yellow-legged frog “sink” populations (areas with negative population growth rates in the absence of immigration) (Bradford *et al.* 1998, p. 2489; Knapp and Matthews 2000, p. 436). Mountain yellow-legged frogs have also been extirpated at some fishless bodies of water (Bradford 1991, p. 176; Drost and Fellers 1996, p. 422). A possible explanation is the isolation and fragmentation of remaining populations due to introduced fishes in the streams that once provided mountain yellow-legged frogs with dispersal and recolonization routes; these remote populations are now non-functional as metapopulations (Bradford 1991, p. 176; Bradford *et al.* 1993, p. 887). Based on a survey of 95 basins within Sequoia and Kings Canyon National Parks, Bradford *et al.* (1993, pp. 885–886) estimated that the introduction of fishes into the study area resulted in an approximately 10-fold increase in habitat fragmentation between populations of mountain yellow-legged frogs. Knapp and Matthews (2000, p. 436) believe that this

fragmentation has further isolated mountain yellow-legged frogs within the already marginal habitat left unused by fishes.

Fragmentation of mountain yellow-legged frog habitat renders populations more vulnerable to extirpation from random events (such as disease) (Wilcox 1980, pp. 114–115; Bradford *et al.* 1993, p. 887; Hanski and Simberloff 1997, p. 21; Knapp and Matthews 2000, p. 436). Isolated population locations may have higher extinction rates because trout prevent successful recolonization and dispersal to and from these sites (Bradford *et al.* 1993, p. 887; Blaustein *et al.* 1994a, p. 7; Knapp and Matthews 2000, p. 436). If the distance between sites is too great, amphibians may not readily recolonize unoccupied sites following local extinctions because of physiological constraints, the tendency to move only short distances, and high site fidelity. Finally, frogs that do attempt recolonization may emigrate into fish-occupied habitat and perish, rendering sites with such metapopulation dynamics less able to sustain frog populations.

In 2001, CDFW revised fish stocking practices and implemented an informal policy on fish stocking in the range of the Sierra Nevada yellow-legged frog and northern DPS of the mountain yellow-legged frog. This policy directs that: (1) Fish will not be stocked in lakes with known populations of mountain yellow-legged frogs, nor in lakes that have not yet been surveyed for mountain yellow-legged frog presence; (2) waters will be stocked only with a fisheries management justification; and (3) the number of stocked lakes will be reduced over time. In 2001, the number of lakes stocked with fish within the range of the mountain yellow-legged frog in the Sierra Nevada was reduced by

75 percent (Milliron 2002, pp. 6–7; Pert *et al.* 2002, pers. comm.). Current CDFW guidelines stipulate that water bodies within the same basin and 2 km (1.25 mi) from a known mountain yellow-legged frog population will not be stocked with fish unless stocking is justified through a management plan that considers all the aquatic resources in the basin, or unless there is heavy angler use and no opportunity to improve the mountain yellow-legged frog habitat (Milliron 2002a, p. 5). The Hatchery and Stocking Program Environmental Impact Report/Environmental Impact Statement, finalized in 2010 (ICF Jones & Stokes 2010, Appendix K), outlines a decision approach to mitigate fish stocking effects on Sierra amphibians that prohibits fish stocking in lakes with confirmed presence of a limited number of designated species, including the mountain yellow-legged frogs (see ICF Jones & Stokes 2010, Appendix E) using recognized survey protocols. Large reservoirs generally continue to be stocked to provide a put-and-take fishery for recreational angling.

As part of the High Mountain Lakes Project, CDFW is in the process of developing management plans for basins within the range of the Sierra Nevada yellow-legged frog and the northern DPS of mountain yellow-legged frog (CDFG (CDFW) 2001, p. 1; Lockhart 2011, pers. comm.). CDFW states that objectives of the basin plans specific to the mountain yellow-legged frog include management in a manner that maintains or restores native biodiversity and habitat quality, supports viable populations of native species, and provides for recreational opportunities that consider historical use patterns (CDFG (CDFW) 2001, p. 3). They state that, under this approach, lakes that support mountain yellow-legged populations in breeding, foraging, or dispersal, and/or

present opportunities to restore or expand habitat, are managed for the conservation of the species. Lakes that do not support mountain yellow-legged frogs are not viable restoration opportunities, and lakes that support trout populations are managed primarily for recreational angling (CDFG (CDFW) 2001, p. 3). They further note that lakes managed for recreational angling may be stocked if CDFW determines that stocking the lake will achieve a desirable fisheries management objective and is not otherwise precluded by stocking decision guidelines and agreements (for stocking decision documents, see CDFW 2013, pp. 1, 2).

Since the mid-1990s, various parties, including researchers, CDFW, NPS, and the USFS, have implemented a variety of projects to actively restore habitat for the mountain yellow-legged frog via the removal of nonnative trout (USFS 2011, pp. 128–130; NPS 2013, pp. 3–5).

Although fish stocking has been curtailed within many occupied basins, the impacts to frog populations persist due to the presence of self-sustaining fish populations in some of the best habitat that normally would have sustained mountain yellow-legged frogs. The fragmentation that persists across the range of these frog species renders them more vulnerable to other population stressors, and recovery is slow, if not impossible, without costly and physically difficult direct human intervention (such as physical and chemical trout removal) (see Knapp *et al.* 2007a, pp. 11–19). While most of the impacts occurred historically, the impact upon the biogeographic (population/metapopulation) integrity of the species will be long-lasting. Currently, habitat degradation and



fragmentation by fish is considered a highly significant and prevalent threat to persistence and recovery of the species.

### Dams and Water Diversions

While a majority of dams and water diversions within the Sierra Nevada are located at lower elevations (USFS 2011, p. 83), some large reservoirs have been constructed within the historic range of the mountain yellow-legged frog complex. These large reservoirs include, but are not limited to Huntington Lake, Florence Lake, Lake Thomas A. Edison, Saddlebag Lake, Cherry Lake, Hetch Hetchy, Upper and Lower Blue Lakes, Lake Aloha, Silver Lake, Hell Hole Reservoir, French Meadow Reservoir, Lake Spaulding, Alpine Lake, Loon Lake, and Ice House Reservoir. A number of these occur at elevations below the current range of the species, indicating that the network of large water and power projects found at lower elevations does not overlap significantly with the current accepted distribution of the mountain yellow-legged frogs in the Sierra Nevada (CDFW 2013, p. 3).

Kondolf *et al.* (1996, p. 1014) report that dams can have direct effects to riparian habitat through permanent removal of habitat to construct roads, penstocks, powerhouses, canals, and dams. Impacts of reservoirs include flooding of riparian vegetation and impediments to establishment of new shoreline vegetation by fluctuating water levels. Dams can alter the temperature and sediment load of the rivers they impound (Cole and Landres 1996, p. 175). Dams, water diversions, and their associated structures can also

alter the natural flow regime with unseasonal and fluctuating releases of water (Kondolf *et al.* 1996, p. 1014). We expect most such effects to occur in stream systems below the extant range of the mountain yellow-legged frogs, although it is possible that stream localities at the northern extent of the range or at low elevations may be affected (see also CDFW 2013, pp. 2–4).

The extent of past impacts to mountain yellow-legged frog populations from habitat loss or modification due to reservoir projects has not been quantified. CDFW (2013, p. 3) has noted that there are locations where the habitat inundated as the result of dam construction (for example, Lake Aloha in the Desolation Wilderness) may have been of higher quality for mountain yellow-legged frogs than the created impoundment. Reservoirs can provide habitat for introduced predators, including fish, bullfrogs, and crayfish, and in some cases, the past construction of reservoirs has facilitated the spread of nonnative fish (CDFW 2013, pp. 3, 4). In such cases, reservoirs may function as barriers to movement of mountain yellow-legged frogs. However, CDFW reported observing mountain yellow-legged frogs dispersing through fishless reservoirs (CDFW 2013, p. 4). (For a complete discussion of the impacts of fish stocking see Habitat Modification Due to Introduction of Trout to Historically Fishless Areas above and the discussion under Factor C.).

Most of the dams constructed within the historic range of the mountain yellow-legged frogs are small streamflow-maintenance dams (CDFW 2013, p. 13) at the outflows of high-elevation lakes. These small dams may create additional habitat for the

species and can act as barriers to fish migration from downstream tributaries into fishless habitats, although they do not impede frog movement (CDFW 2013, p. 3). CDFW staff (2013, p. 13) have observed that extant frog populations may have persisted where such dams have helped to preserve a fishless environment behind the dam.

Based on comments from CDFW and others and the provision of additional information, we have reviewed the analysis of dams and diversions that we presented in the proposed rule. We find that most large facilities are below the current range of the mountain yellow-legged frogs and have revised our finding. In the proposed rule, we stated that dams and diversions presented a moderate, prevalent threat to persistence and recovery of the species. In this final rule, we find that dams and water diversions present a minor, localized threat to persistence and recovery of the species where structures occur.

#### Livestock Use (Grazing)

The combined effect of legacy conditions from historically excessive grazing use and current livestock grazing activities has the potential to impact habitat in the range of the mountain yellow-legged frog. The following subsections discuss the effects of excessive historical grazing, current extent of grazing, and current grazing management practices. As discussed below, grazing has the potential to reduce the suitability of habitat for mountain yellow-legged frogs by reducing its capability to sustain frogs and facilitate dispersal and migration, especially in stream areas.

Grazing of livestock in riparian areas impacts the function of the aquatic system in multiple ways, including soil compaction, which increases runoff and decreases water availability to plants; vegetation removal, which promotes increased soil temperatures and evaporation rates at the soil surface; and direct physical damage to the vegetation (Kauffman and Krueger 1984, pp. 433–434; Cole and Landres 1996, pp. 171–172; Knapp and Matthews 1996, pp. 816–817). Streamside vegetation protects and stabilizes streambanks by binding soils to resist erosion and trap sediment (Kauffman *et al.* 1983, p. 683; Chaney *et al.* 1990, p. 2). Grazing within mountain yellow-legged frog habitat has been observed to remove vegetative cover, potentially exposing frogs to predation and increased desiccation (Knapp 1993b, p. 1; Jennings 1996, p. 539), and to lead to erosion which may silt in ponds and thereby reduce the water depth needed for overwinter survival (Knapp 1993b, p. 1). However, an appropriately managed grazing regime (including timing and intensity) can enhance primary riparian vegetation attributes that are strongly correlated to stream channel and riparian soil stability conditions necessary to maintain a functioning riparian system (George *et al.* 2011, p. 227). Although, where highly degraded conditions such as downcut channels exist, grazing management alone may not be sufficient to restore former riparian conditions (George *et al.* 2011, p. 227).

Aquatic habitat can also be degraded by grazing. Mass erosion from trampling and hoof slide causes streambank collapse and an accelerated rate of soil transport to streams (Meehan and Platts 1978, p. 274). Accelerated rates of erosion lead to elevated instream sediment loads and depositions, and changes in stream-channel morphology

(Meehan and Platts 1978, pp. 275–276; Kauffman and Krueger 1984, p. 432). Livestock grazing may lead to diminished perennial streamflows (Armour *et al.* 1994, p. 10). Livestock can increase nutrient-loading in water bodies due to urination and defecation in or near the water, and can cause elevated bacteria levels in areas where cattle are concentrated (Meehan and Platts 1978, p. 276; Stephenson and Street 1978, p. 156; Kauffman and Krueger 1984, p. 432). With increased grazing intensity, these adverse effects to the aquatic ecosystem increase proportionately (Meehan and Platts 1978, p. 275; Clary and Kinney 2000, p. 294).

Observational data indicate that livestock can negatively impact mountain yellow-legged frogs by altering riparian habitat (Knapp 1993a, p. 1; 1993b, p. 1; 1994, p. 3; Jennings 1996, p. 938; Carlson 2002, pers. comm.; Knapp 2002a, p. 29). Livestock tend to concentrate along streams and wet areas where there is water and herbaceous vegetation; grazing impacts are, therefore, most pronounced in these habitats (Meehan and Platts 1978, p. 274; U.S. Government Accounting Office (GAO) 1988, pp. 10–11; Fleischner 1994, p. 635; Menke *et al.* 1996, p. 17). This concentration of livestock contributes to the destabilization of streambanks, causing undercuts and bank failures (Kauffman *et al.* 1983, p. 684; Marlow and Pogacnik 1985, pp. 282–283; Knapp and Matthews 1996, p. 816; Moyle 2002, p. 55). Grazing activity can contribute to the downcutting of streambeds and lower the water table. The degree of erosion caused by livestock grazing can vary with slope gradient, aspect, soil condition, vegetation density, and accessibility to livestock, with soil disturbance greater in areas overused by livestock (Meehan and Platts 1978, pp. 275–276; Kauffman *et al.* 1983, p. 685; Kauffman and

Krueger 1984, p. 432; Bohn and Buckhouse 1985, p. 378; GAO 1988, p. 11; Armour *et al.* 1994, pp. 9–11; Moyle 2002, p. 55).

Livestock grazing may impact other wetland systems, including ponds that can serve as mountain yellow-legged frog habitat. Grazing can modify shoreline habitats by removing overhanging banks that provide shelter, and grazing contributes to the siltation of breeding ponds. Bradford (1983, p. 1179) and Pope (1999, pp. 43–44) have documented the importance of deep lakes to overwinter survival of these species. We expect that pond siltation due to grazing may reduce the depth of breeding ponds and cover underwater crevices in some circumstances where grazing is heavy and where soils are highly erodible, thereby making the ponds less suitable, or unsuitable, as overwintering habitat for tadpoles and adult mountain yellow-legged frogs.

### *Effects of Excessive Historical Grazing*

In general, historical livestock grazing within the range of the mountain yellow-legged frog was at a high (although undocumented), unregulated and unsustainable level until the establishment of National Parks (beginning in 1890) and National Forests (beginning in 1905) (UC 1996a, p. 114; Menke *et al.* 1996, p. 14). Historical evidence indicates that heavy livestock use in the Sierra Nevada has resulted in widespread damage to rangelands and riparian systems due to sod destruction in meadows, vegetation destruction, and gully erosion (see review in Brown *et al.* 2009, pp. 56–58). Within the newly established National Parks, grazing by cattle and sheep was eliminated, although

grazing by packstock, such as horses and mules, continued. Within the National Forests, the amount of livestock grazing was gradually reduced, and the types of animals shifted away from sheep and toward cattle and packstock, with cattle becoming the dominant livestock. During World Wars I and II, increased livestock use occurred on National Forests in the west, causing overuse in the periods 1914–1920 and 1939–1946. Between 1950 and 1970 livestock numbers were permanently reduced due to allotment closures and uneconomical operations, with increased emphasis on resource protection and riparian enhancement. Further reductions in livestock use began again in the 1990s, due in part to USFS reductions in permitted livestock numbers, seasons of use, implementation of rest-rotation grazing systems, and to responses to drought (Menke *et al.* 1996, pp. 7, 8). Between 1981 and 1998, livestock numbers on National Forests in the Sierra Nevada decreased from 163,000 to approximately 97,000 head, concurrent with Forest Service implementation of standards and guidelines for grazing and other resource management (USFS 2001, pp. 399–416).

### *Effects of Current Grazing*

Yosemite, Sequoia, and Kings Canyon National Parks remain closed to livestock grazing. On USFS-administered lands that overlap the historical ranges of the mountain yellow-legged frog in the Sierra Nevada, there are currently 161 active Rangeland Management Unit Allotments for livestock grazing. However, based on frog surveys performed since 2005, only 27 of these allotments have extant mountain yellow-legged frog populations, while some allotments that were located in sensitive areas have been

closed (USFS 2008, unpubl. data; CDFW (CDFG) unpubl. data). As of 2009, USFS data indicated that grazing occurs on about 65 percent of National Forest lands within the range of the mountain yellow-legged frog; that livestock numbers remain greatly reduced from historical levels; and that numerous watershed restoration projects have been implemented, although grazing may still impact many meadows above mid-elevation and restoration efforts are far from complete (Brown *et al.* 2009, pp. 56, 57). However, Brown *et al.* (2009, p. 56) report that livestock grazing is more likely to occur in certain habitat types used by mountain yellow-legged frogs than others, indicating that populations found in meadows, stream riparian zones, and lakes in meadows are more likely to encounter habitat effects of grazing than populations found in the deeper alpine lakes that the species more likely inhabit (Brown *et al.* 2009, p. 56).

USFS standards and guidelines in forest land and resource management plans have been implemented to protect water quality, sensitive species, vegetation, and stream morphology. Further, USFS standards have been implemented in remaining allotments to protect aquatic habitats (see discussion of the aquatic management strategy under **Factor D** for examples). USFS data from long-term meadow monitoring collected from 1999 to 2006 indicate that most meadows appear to be in an intermediate quality condition class, with seeming limited change in condition class over the first 6 years of monitoring. In addition, USFS grazing standards and guidelines are based on current science and are designed to improve or maintain range ecological conditions, and standards for managing habitat for threatened, endangered, and sensitive species have also been incorporated (Brown *et al.* 2009, pp. 56–58). The seasonal turn-out dates



(dates at which livestock are permitted to move onto USFS allotments) are set yearly based on factors such as elevation, annual precipitation, soil moisture, and forage plant phenology, and meadow readiness dates are also set for montane meadows. However, animals turned out to graze on low-elevation range (until higher elevation meadows are ready) may reach upper portions of allotments before the meadows have reached range readiness (Brown *et al.* 2009, p. 58).

Menke *et al.* (1996) have reported that grazing livestock in numbers that are consistent with grazing capacity and use of sustainable methods led to better range management in the Sierra Nevada over the 20 years prior to development of the report. They also noted that moderate livestock grazing has the potential to increase native species diversity in wet and mesic meadows by allowing native plant cover to increase on site. Brown *et al.* (2009, p. 58) expect proper livestock management, such as proper timing, intensity, and duration, to result in a trend towards increased riparian species and a trend towards restored wet and mesic meadows on National Forests. To date, the scientific and commercial information available to us does not include descriptive or cause-effect research that establishes a causal link between habitat effects of livestock grazing and mountain yellow-legged frog populations; however, anecdotal information of specific habitat effects suggests that, in specific locations, the current grazing levels may have population-level effects (see Knapp 1993b, p. 1; Brown *et al.* 2009, p. 56). In addition, where low-elevation populations occur in meadows, additional conservation measures may be required for recovery (USFS 2013, p. 5).

In summary, the legacy effects to habitat from historical grazing levels, such as increased erosion, stream downcutting and headcutting, lowered water tables, and increased siltation, are a threat to mountain yellow-legged frogs in those areas where such conditions still occur and may need active restoration. In the proposed rule, we stated that grazing presented a minor prevalent threat. Based on USFS and public comments, we have reevaluated our analysis of grazing to clarify effects of past versus current grazing. We have reworded the finding to more accurately reflect the contribution of legacy effects of past grazing levels to this threat assessment, as follows: Current livestock grazing activities may present an ongoing, localized threat to individual populations in locations where the populations occur in stream riparian zones and in small waters within meadow systems, where active grazing co-occurs with extant frog populations. Livestock grazing that complies with forest standards and guidelines is not expected to negatively affect mountain yellow-legged frog populations in most cases, although limited exceptions could occur, especially where extant habitat is limited. In addition, mountain yellow-legged frogs may be negatively affected where grazing standards are exceeded. Rangewide, current livestock grazing is not a substantial threat to the species.

## Mining

Several types of mining activities have occurred, or may currently occur, on National Forests, including aggregate mining (the extraction of materials from streams or stream terraces for use in construction), hardrock mining (the extraction of minerals by

drilling or digging into solid rock), hydraulic mining (a historical practice using pressurized water to erode hillsides, outlawed in 1884), placer mining (mining in sand or gravel, or on the surface, without resorting to mechanically assisted means or explosives), and suction-dredge mining (the extraction of gold from riverine materials, in which water, sediment, and rocks are vacuumed from portions of streams and rivers, sorted to obtain gold, and the spoils redeposited in the stream (see review in Brown *et al.* 2009, pp. 62–64).

Aggregate mining can alter sediment transport in streams, altering and incising stream channels, and can cause downstream deposition of sediment, altering or eliminating habitat. Aggregate mining typically occurs in large riverine channels that are downstream of much of the range of the mountain yellow-legged frog complex (see review in Brown *et al.* 2009, pp. 62–64). However, Brown *et al.* (2009, pp. 62–64) note that effects of aggregate mining may occur in some portions of the Feather River system where such operations occur within the historic range of the Sierra Nevada yellow-legged frog, and potentially in localized areas within the range of both species, where the USFS maintains small quarries for road work. They note that, although effects of aggregate mining on mountain yellow-legged frogs are unstudied, impacts are probably slight.

Hardrock mining can be a source of pollution where potentially toxic metals are solubilized by waters that are slightly acidic. Past mining activities have resulted in the existence of many shaft or tunnel mines on the forest in the Sierra Nevada, although most are thought to occur below the range of the species. Most operations that are thought to

have the potential to impact the mountain yellow-legged frogs occur in the lower elevation portions of the Sierra Nevada yellow-legged frog range on the Plumas National Forest and in the ranges of both species on the Inyo National Forest (see review in Brown *et al.* 2009, pp. 62–64).

Hydraulic mining has exposed previously concealed rocks that can increase pollutants such as acid, cadmium, mercury, and asbestos, and its effect on water pollution may still be apparent on the Feather River. However, most of the area that was mined in this way is below the elevation where Sierra Nevada yellow-legged frogs are present, so effects are likely highly localized (see review in Brown *et al.* 2009, pp. 63, 64).

Although placer mining was dominant historically, today it's almost exclusively recreational and is not expected to have habitat-related effects.

Brown *et al.* (2009, p. 64) report that suction-dredge mining is also primarily recreational noting that, because nozzles are currently restricted to 6 inches or smaller, CDFW (CDFG, 1994) expects disturbed areas to recover quickly (although CDFW notes that such dredging may increase suspended sediments, change stream geomorphology, and bury or suffocate larvae). Suction dredge mining occurs primarily in the foothills of the Sierra Nevada, thus presenting a risk primarily to mountain yellow-legged frog populations at the lower elevations of the species' range. Suction dredging is highly regulated by the CDFW, and in the past, many streams have been seasonally or permanently closed (see review in Brown *et al.* 2009, p. 64). Currently CDFW has imposed a moratorium on suction dredging.

The high-elevation areas where most Sierra Nevada yellow-legged frogs and mountain yellow-legged frogs occur are within designated wilderness, where mechanical uses are prohibited by the Wilderness Act. Designated wilderness was withdrawn for new mining claims on January 1, 1984, although a limited number of active mines that predated the withdrawal still occur within wilderness (see Wilderness Act under Factor D, below). Therefore, we expect that mining activities may pose local habitat-related impacts to the species at specific localities where mining occurs.

#### Packstock Use

Similar to cattle, horses and mules may significantly overgraze, trample, or pollute riparian and aquatic habitat if too many are concentrated in riparian areas too often or for too long. Commercial packstock trips are permitted in National Forests and National Parks within the Sierra Nevada, often providing transport services into wilderness areas through the use of horses or mules. Use of packstock in the Sierra Nevada increased after World War II as road access, leisure time, and disposable income increased (Menke *et al.* 1996, p. 919). Packstock grazing is the only grazing currently permitted in the National Parks of the Sierra Nevada. Since the mid-1970s, National Forests and National Parks have generally implemented regulations to manage visitor use and group sizes, including measures to reduce packstock impacts to vegetation and soils in order to protect wilderness resources. For example, Sequoia and Kings Canyon National Parks have the backcountry area with the longest history of research and

management of packstock impacts (Hendee *et al.* 1990, p. 461). Hendee *et al.* (1990, p. 461) report that the extensive and long-term monitoring for Sequoia, Kings Canyon, and Yosemite National Parks makes it possible to quantify impacts of packstock use, showing that the vast majority of Sierra Nevada yellow-legged frog and mountain yellow-legged frog populations in the Parks show no to negligible impacts from packstock use (National Park Service 2013, p. 3). In the Sixty-Lakes Basin of Kings Canyon National Park, packstock use is regulated in wet meadows to protect mountain yellow-legged frog breeding habitat in bogs and along lake shores from trampling and associated degradation (Vredenburg 2002, p. 11; Werner 2002, p. 2; National Park Service 2013, p. 3). Packstock use is also regulated in designated wilderness in National Forests within the Sierra Nevada.

Packstock use is likely a threat of low significance to mountain yellow-legged frogs at the current time, except on a limited, site-specific basis. As California's human population increases, the impact of recreational activities, including packstock use and riding on the National Forests in the Sierra Nevada, are projected to increase (USDA 2001a, pp. 473–474). However, on the Inyo National Forest, current commercial packstock use is approximately 27 percent of the level of use in the 1980s reflecting a decline in the public's need and demand for packstock trips. From 2001 to 2005, commercial packstock outfitters within the Golden Trout and South Sierra Wilderness Areas averaged 28 percent of their current authorized use (USFS 2006, p. 3-18). Similarly, long-term permitting data for administrative, commercial, and recreational packstock use in the three National Parks indicates that packstock use is declining in the

Parks, providing no evidence to suggest that packstock use will increase in the future in the Parks (National Park Service 2013, pp. 3, 4). Habitat changes due to packstock grazing may pose a risk to some remnant populations of frogs and, in certain circumstances, a hindrance to recovery of populations in heavily used areas.

## Roads and Timber Harvest

Activities that alter the terrestrial environment (such as road construction and timber harvest) may impact amphibian populations in the Sierra Nevada (Jennings 1996, p. 938) at locations where these activities occur. Historically, road construction and timber harvest may have acted to reduce the species' range prior to the more recent detailed studies and systematic monitoring that have quantified and documented species losses. Prior to the formation of National Parks in 1890 and National Forests in 1905, timber harvest was widespread and unregulated, but primarily took place at elevations on the western slope of the Sierra Nevada below the range of the mountain yellow-legged frog (University of California (UC) 1996b, pp. 24–25). Between 1900 and 1950, the majority of timber harvest occurred in old-growth forests on private land (UC 1996b, p. 25). Between 1950 and the early 1990s, timber harvest on National Forests increased, and the majority of timber harvest-associated impacts on mountain yellow-legged frogs may therefore have taken place during this period in lower elevation locations where timber harvest and species occurrences overlapped. Currently, these activities are expected to occur outside National Parks or National Forest wilderness areas, with limited exceptions.

Timber harvest activities (including vegetation management and fuels management) remove vegetation and cause ground disturbance and compaction, making the ground more susceptible to erosion (Helms and Tappeiner 1996, p. 446). This erosion can increase siltation downstream and potentially damage mountain yellow-legged frog breeding habitat. Timber harvest may alter the annual hydrograph (timing and volume of surface flows) in areas where harvests occur. The majority of erosion caused by timber harvests is from logging roads (Helms and Tappeiner 1996, p. 447). A recent monitoring effort, which was conducted by the USFS in stream habitats in the northern part of the Sierra Nevada yellow-legged frog's range, attempted to assess the impact of vegetation management activities, which would include activities similar to timber harvest, on mountain yellow-legged frog populations (Foote *et al.* 2013, p. 2). However, given the timing of project implementation, the results were limited to the impacts of these management activities on mountain yellow-legged frog habitat. The results of the monitoring suggest these activities did not significantly impact perennial stream habitat for the mountain yellow-legged frog, although there were instances of habitat degradation attributed to sedimentation resulting from road decommissioning and culvert replacement (Foote *et al.* 2013, p. 32).

Roadways have the potential to affect riparian habitat by altering the physical and chemical environment, including alteration of surface-water run-off, with potential changes to hydrology in high-mountain lake and stream systems (Brown *et al.* 2009, pp. 71–72). Roads, including those associated with timber harvests, have also been found to



contribute to habitat fragmentation and limit amphibian movement, thus having a negative effect on amphibian species richness. Therefore, road construction could fragment mountain yellow-legged frog habitat if a road bisects habitat consisting of water bodies in close proximity. In the prairies and forests of Minnesota, Lehtinen *et al.* (1999, pp. 8–9) found that increased road density reduced amphibian species richness. DeMaynadier and Hunter (2000, p. 56) found similar results in a study of eight amphibian species in Maine, although results varied with road type and width. Results showed that anuran (true frogs, the group of frogs that includes the mountain yellow-legged frogs) habitat use and movement were not affected even by a wide, heavily used logging road (deMaynadier and Hunter 2000, p. 56); this finding suggests that forest roads may not fragment populations where such roads occur.

Currently, most of the mountain yellow-legged frog populations occur in National Parks or designated wilderness areas where timber is not harvested (Bradford *et al.* 1994, p. 323; Drost and Fellers 1996, p. 421; Knapp and Matthews 2000, p. 430) and where motorized access (and roads) does not occur. Mountain yellow-legged frog populations outside of these areas are most often located above the timberline, so timber harvest activity is not expected to affect the majority of extant mountain yellow-legged frog populations. There is a higher potential overlap of timber harvest activities with the species in the northern and lower elevation portions of the species' ranges where the frogs occur in streams and meadows in forested environments; in these areas, populations are very small and fragmented (Brown 2013, unpaginated). Likewise, at lower elevations of the Sierra Nevada, forest roads and logging roads are more common (Brown *et al.*

2009, p. 71). Habitat effects associated with roads are most likely to occur where existing roadways occur (for example, see Knapp 1993b, unpaginated). Although additional roads may be constructed within the range of the mountain yellow-legged frogs, we are not aware of any proposals to build new roads at this time.

In riparian areas, the USFS generally maintains standards and guidelines for land management activities, such as timber harvests, that are designed to maintain the hydrologic, geomorphic, and ecologic processes that directly affect streams, stream processes, and aquatic habitats, and which can limit potential effects of such activities (Foote *et al.* 2013, pp. 4, 32). In general, we expect the standards to be effective in preventing habitat-related effects to these species. Additionally, neither timber harvests nor roads have been implicated as important contributors to the decline of this species (Jennings 1996, pp. 921–941), although habitat alterations due to these activities may, in site-specific, localized cases, have population-level effects to mountain yellow-legged frogs. We expect that such cases would be more likely at lower elevations or in the more northern portion of the species' range where limited extant populations occur in close proximity to timber harvest, or where populations occur in drainages adjacent to roadways. In the proposed rule, we stated that roads and timber harvest likely present minor prevalent threats to the mountain yellow-legged frogs factored across the range of the species. We are clarifying that language, noting that they may pose important habitat-related effects to the species in localized areas, but are not likely threats across most of the species' ranges.

## Fire and Fire Management Activities

Mountain yellow-legged frogs are generally found at high elevations in wilderness areas and National Parks where vegetation is sparse and where fire may have historically played a limited role in the ecosystem. However, at lower elevations and in the northern portion of the range, mountain yellow-legged frogs occur in stream or lake environments within areas that are forested to various extents. In some areas within the current range of the mountain yellow-legged frog, long-term fire suppression has changed the forest structure and created conditions that increase fire severity and intensity (McKelvey *et al.* 1996, pp. 1934–1935). Excessive erosion and siltation of mountain yellow-legged frog habitats following wildfire is a concern where shallow, lower elevation aquatic areas occur below forested stands. However, prescribed fire has been used by land managers to achieve various silvicultural objectives, including fuel load reduction. In some systems, fire is thought to be important in maintaining open aquatic and riparian habitats for amphibians (Russell *et al.* 1999, p. 378), although severe and intense wildfires may reduce amphibian survival, as the moist and permeable skin of amphibians increases their susceptibility to heat and desiccation (Russell *et al.* 1999, p. 374). Amphibians may avoid direct mortality from fire by retreating to wet habitats or sheltering in subterranean burrows.

The effects of past fire and fire management activities on historical populations of mountain yellow-legged frogs are not known. Neither the direct nor indirect effects of prescribed fire or wildfire on the mountain yellow-legged frog have been studied.

Hossack *et al.* (2012, pp. 221, 226), in a study of the effects of six stand-replacing fires on three amphibians that breed in temporary ponds in low-elevation dense coniferous forests or in high-elevation open, subalpine forests in Glacier National Park, found that effects of wildfire on amphibians may not be evident for several years post-fire with time-lagged declines. The decline in populations was presumably due to the proximity of high-severity fires to important breeding habitats, which resulted in low recruitment of juveniles into the breeding population. They cautioned, however, that amphibian responses to fire are context specific and cannot be generalized too broadly; they found no change in occupancy after wildfire at high elevations where wetlands were in sparse forest or open meadows where there was less change in canopy cover and insolation after wildfire. Where fire has occurred in the steep canyons of southern California where the southern DPS of the mountain yellow-legged frog occurs, the character of the habitat has been significantly altered, leading to erosive scouring and flooding of creeks after surface vegetation is denuded (North 2012, pers. comm.). North (2012, pers. comm.) reported that at least one population of the federally endangered southern DPS of the mountain yellow-legged frog, which occurs in streams, declined substantially after fire on the East Fork City Creek (San Bernardino Mountains) in 2003 and, by 2012, was approaching extirpation. Although most populations of mountain yellow-legged frogs are in alpine habitat that differs from the habitat in southern California, when they occur in lower-elevation stream habitats, they could be similarly affected by large wildfires. When a large fire does occur in occupied habitat, mountain yellow-legged frogs can be susceptible to both direct mortality (leading to significantly reduced population sizes) and indirect effects (habitat alteration and reduced breeding habitat). It is possible that fire

has caused localized extirpations in the past. However, because these species generally occupy high-elevation habitat, we have determined that fire is not a significant threat to the mountain yellow-legged frog complex over much of its current range, although where the species occur at lower elevations or in the most northerly portion of their ranges, fire-related changes to habitat may have population-level effects to the species.

## Recreation

Recreational activities that include hiking, camping, and backpacking take place throughout the Sierra Nevada, whereas off-road vehicle (ORV) use takes place in areas outside of designated wilderness. These activities can have significant negative impacts on many plant and animal species and their habitats (U.S. Department of Agriculture (USDA) 2001a, pp. 483–493). Extant populations of the mountain yellow-legged frog complex are primarily located at high elevations in sub-alpine and alpine habitat within designated wilderness. High-elevation wilderness areas are ecosystems that are subject to intense solar exposure; extremes in temperatures, precipitation levels, and wind; short growing seasons; and shallow, nutrient-poor soil. Such habitats are typically not resilient to disturbance (Schoenherr 1992, p. 167; Cole and Landres 1996, p. 170).

In easily accessible areas, heavy foot traffic in riparian areas can trample vegetation, compact soils, and physically damage stream banks (Kondolf *et al.* 1996, pp. 1014, 1019). Human foot, horse, bicycle, or off-highway motor vehicle trails can replace riparian habitat with compacted soil (Kondolph *et al.* 1996, pp. 1014, 1017, 1019), lower

the water table, and cause increased erosion where such activities occur. Bahls (1992, p. 190) reported that the recreational activity of anglers at high mountain lakes can be locally intense in western wilderness areas, with most regions reporting a level of use greater than the fragile lakeshore environments can withstand. Heavy recreation use has been associated with changes in the basic ecology of lakes. In the 1970s, Silverman and Erman (1979) found that the most heavily used back-country lakes in their study had less nitrate and more iron and aquatic plants than other lakes. These researchers suggested that erosion at trails and campsites, improper waste disposal, destruction of vegetation, and campsites might cause an increase in elements that formerly limited plant growth (Hendee *et al.* 1990, pp. 435, 436). The NPS considers hiking and backpacking to be a negligible risk for the mountain yellow-legged frogs within the Parks, noting that, while hiking and backpacking occur adjacent to many populations, evidence indicates that risk to habitat is slight to none. For example, monitoring of a high-use trail that allows thousands of hikers annually to come into close contact with several populations of mountain yellow-legged frogs, whose habitat is immediately adjacent to the trail, shows that the populations have grown substantially over the last decade (NPS 2013, p. 6). In one location where high hiking levels may be having an impact due to access via an adjacent road, Yosemite National Park personnel have restricted access (NPS 2013, p. 6). Although recreation was noted in 1998 as the fastest growing use of National Forests (USFS 2001a, p. 453), to our knowledge, no studies to date have identified a correlation between such recreation-related impacts to habitat and effects to populations of the mountain yellow-legged frog complex.

Because of demand for wilderness recreational experiences and concern about wilderness resource conditions, wilderness land management now includes standards for wilderness conditions, implementing permit systems and group-size limits for visitors and packstock, prohibitions on camping and packstock use close to water, and other visitor management techniques to reduce impacts to habitat, including riparian habitat (Cole 2001, pp. 4–5). These wilderness land management techniques are currently being used in National Forest Wilderness areas in the Sierra Nevada and in backcountry areas of Yosemite, Sequoia, and Kings Canyon National Parks. In the proposed rule, we stated that current recreation activities were considered a threat of low significance to the species' habitat overall. Based on comments from the National Park Service, the USFS, CDFW, and the public, we have reevaluated the previous analysis and have revised our finding. Therefore, current habitat effects of recreational activities are not considered to have population-level effects to mountain yellow-legged frogs over much of their respective ranges, although there may be localized effects especially outside of backcountry areas where use levels are not limited, or where motorized use occurs in extant frog habitat.

In summary, based on the best available scientific and commercial information, we consider the modification of habitat and curtailment of the species' ranges to be a significant and ongoing threat to the Sierra Nevada yellow-legged frog and northern DPS of the mountain yellow-legged frog. Habitat fragmentation and degradation (loss of habitat through competitive exclusion) from stocking and the continued presence of introduced trout across the majority of the species' range is a threat of high prevalence.

This threat is a significant limiting factor to persistence and recovery of the species rangewide. Threats of low prevalence (threats that may be important limiting factors in some areas, but not across a large part of the mountain yellow-legged frog complex's range) include dams and water diversions, grazing, packstock use, timber harvest and roads, recreation, and fire management activities.

*Factor B. Overutilization for Commercial, Recreational, Scientific, or Educational Purposes*

No commercial market for mountain yellow-legged frogs exists, nor any documented recreational or educational uses for these species. Scientific research may cause stress to mountain yellow-legged frogs through disturbance, including disruption of the species' behavior, handling of individual frogs, and injuries associated with marking and tracking individuals. However, this is a relatively minor nuisance and not likely a negative impact to the survival and reproduction of individuals or the viability of the populations.

Based on the best available scientific and commercial information, we do not consider overutilization for commercial, recreational, scientific, or educational purposes to be a threat to the mountain yellow-legged frog complex now or in the future.

*Factor C. Disease or Predation*

**Predation**



Researchers have observed predation of mountain yellow-legged frogs by the mountain garter snake (*Thamnophis elegans elegans*), Brewer's blackbird (*Euphagus cyanocephalus*), Clark's nutcracker (*Nucifraga columbiana*), coyote (*Canis latrans*), and black bear (*Ursus americanus*) (Mullally and Cunningham 1956a, p. 193; Bradford 1991, pp. 176–177; Jennings *et al.* 1992, p. 505; Feldman and Wilkinson 2000, p. 102; Vredenburg *et al.* 2005, p. 565). However, none of these has been implicated as a driver of population dynamics, and we expect that such predation events do not generally have population-level impacts except where so few individuals remain that such predation is associated with loss of a population (Bradford 1991, pp 174–177; Jennings 1996, p. 938).

The American bullfrog (*Lithobates catesbeiana*) is native to the United States east of the Rocky Mountains, but was introduced to California about a century ago. The American bullfrog has become common in California in most permanent lakes and ponds below 1,829 m (6,000 ft) and is implicated in the declines of a number of native frog species (Jennings 1996, p. 931). Mountain yellow-legged frogs are thought to be particularly vulnerable to bullfrogs and introduced crayfish, potentially because the frogs did not evolve with a predator (Jennings 1996, p. 939). In addition, research indicates that bullfrogs may outcompete other species of amphibians where fish are present because bullfrogs are both unpalatable to fish and are naturally vulnerable to invertebrate predators such as dragonfly (Anisoptera) nymphs, which fish preferentially consume. Bullfrogs may co-occur with mountain yellow-legged frogs at lower elevations. On the Plumas National Forest, sites created as a result of restoration activities have been

invaded by bullfrogs (Brown *et al.* 2009, pp. 48, 49). Bullfrogs also occur in the Lake Tahoe Basin (USFS 2000, pp. 530, G–12) in the vicinity of Fallen Leaf Lake. Bullfrog predation and competition is expected to have population-level effects where bullfrog populations occupy the same areas as extant mountain yellow-legged frog populations.

The most prominent predator of mountain yellow-legged frogs is introduced trout, whose significance is well-established because it has been repeatedly observed that the frogs rarely coexist with fish, and it is known that introduced trout can and do prey on all frog life stages except for eggs (Grinnell and Storer 1924, p. 664; Mullally and Cunningham 1956a, p. 190; Cory 1962a, p. 401; 1963, p. 172; Bradford 1989, pp. 775–778; Bradford and Gordon 1992, p. 65; Bradford *et al.* 1993, pp. 882–888; 1994a, p. 326; Drost and Fellers 1996, p. 422; Jennings 1996, p. 940; Knapp 1996, p. 14; Knapp and Matthews 2000, p. 428; Knapp *et al.* 2001, p. 401; Vredenburg 2004, p. 7649; Knapp 2013, unpaginated). Knapp (1996, pp. 1–44) estimated that 63 percent of lakes larger than 1 ha (2.5 ac) in the Sierra Nevada contain one or more nonnative trout species, and that greater than 60 percent of streams contain nonnative trout. In some areas, trout-occupied waters comprise greater than 90 percent of total water body surface area (Knapp and Matthews 2000, p. 434).

The multiple-year tadpole stage of the mountain yellow-legged frog requires submersion in the aquatic habitat year-round until metamorphosis. Moreover, all life stages are highly aquatic, increasing the frog's susceptibility to predation by trout (where they co-occur) throughout its lifespan. Overwinter mortality due to predation is

especially significant because, when water bodies ice over in winter, adults and tadpoles move from shallow margins of lakes and ponds into deeper unfrozen water where they are more vulnerable to predation; fish encounters in such areas increase, while refuge is less available.

The predation of mountain yellow-legged frogs by fishes observed in the early 20<sup>th</sup> century by Grinnell and Storer and the documented population declines of the 1970s (Bradford 1991, pp. 174–177; Bradford *et al.* 1994, pp. 323–327; Stebbins and Cohen 1995, pp. 226–227) were not the beginning of the mountain yellow-legged frog's decline, but rather the continuation of a long decline that started soon after fish introductions to the Sierra Nevada began in the mid-1800s (Knapp and Matthews 2000, p. 436). Metapopulation theory (Hanski 1997, pp. 85–86) predicts this type of time lag from habitat modification to population extinction (Knapp and Matthews 2000, p. 436). In 2004, Vredenburg (2004, p. 7647) concluded that introduced trout are effective predators on mountain yellow-legged frog tadpoles and suggested that the introduction of trout is the most likely reason for the decline of the mountain yellow-legged frog complex. This threat due to predation by introduced trout is a significant, prevalent (rangewide) risk to mountain yellow-legged frogs, and it will persist into the future in those locations where fish are present. The effect of introduced bullfrogs is expected to be a substantial continuing threat in those locations where bullfrogs are known to occur presently, but may present more of a future threat if bullfrogs expand their elevational range as a result of climate change.

## Disease

Over roughly the last 2 decades, pathogens have been associated with amphibian population declines, mass die-offs, and even extinctions worldwide (Bradford 1991, pp. 174–177; Blaustein *et al.* 1994b, pp. 251–254; Alford and Richards 1999, pp. 506; Muths *et al.* 2003, p. 357; Weldon *et al.* 2004, p. 2100; Rachowicz *et al.* 2005, p. 1446; Fisher *et al.* 2009, p. 292). One pathogen strongly associated with dramatic declines on all continents that harbor amphibians (all continents except Antarctica) is the chytrid fungus, *Batrachochytrium dendrobatidis* (Bd) (Rachowicz *et al.* 2005, p. 1442). This chytrid fungus has now been reported in amphibian species worldwide (Fellers *et al.* 2001, p. 945; Rachowicz *et al.* 2005, p. 1442). Early doubt that this particular pathogen was responsible for worldwide die-offs has largely been overcome by the weight of evidence documenting the appearance, spread, and detrimental effects to affected populations (Vredenburg *et al.* 2010, p. 9689). The correlation of notable recent amphibian declines with reports of outbreaks of fatal chytridiomycosis (the disease caused by Bd) in montane areas has led to a general association between high altitude, cooler climates, and population extirpations associated with Bd (Fisher *et al.* 2009, p. 298).

Bd affects the mouth parts and epidermal (skin) tissue of tadpoles and metamorphosed frogs (Fellers *et al.* 2001, pp. 950–951). The fungus can reproduce asexually, and can generally withstand adverse conditions such as freezing or drought (Briggs *et al.* 2002, p. 38). It also may reproduce sexually, leading to thick-walled sporangia that would be capable of long-term survival (for distant transport and

persistence in sites even after all susceptible host animal populations are extirpated) (Morgan *et al.* 2007, p. 13849). Adult frogs can acquire this fungus from tadpoles, and it can also be transmitted between tadpoles (Rachowicz and Vredenburg 2004, p. 80).

In California, chytridiomycosis has been detected in many amphibian species, including mountain yellow-legged frogs (Briggs *et al.* 2002, p. 38; Knapp 2002b, p. 1). The earliest documented case in the mountain yellow-legged frog complex was in 1998, at Yosemite National Park (Fellers *et al.* 2001, p. 945); however, more recent literature shows Bd occurring in mountain yellow-legged frogs as early as 1975 (Ouellet *et al.* (2005, p. 1436; Vredenberg *et al.* 2010, p. 9689). It is unclear how Bd was originally transmitted to the frogs (Briggs *et al.* 2002, p. 39). Visual examination of 43 tadpole specimens collected between 1955 and 1976 revealed no evidence of Bd infection, yet 14 of 36 specimens preserved between 1993 and 1999 did have abnormalities attributable to Bd (Fellers *et al.* 2001, p. 947). The earliest recorded case of Bd in mountain yellow-legged frogs is from 1975, and Bd was also identified on two adult Yosemite toads among over 50 dead, dying, or healthy Yosemite toads collected during a die-off in 1976 (Green and Kagarise Sherman 2001, p. 92), although it was not thought to be the cause of the die-off in the population. Given these records, it is possible that this pathogen has affected all three amphibian species covered in this final rule since at least the mid-1970s. Mountain yellow-legged frogs may be especially vulnerable to Bd infections because all life stages share the same aquatic habitat nearly year round, facilitating the transmission of this fungus among individuals at different life stages (Fellers *et al.* 2001, p. 951).

During the epidemic phase of chytrid infection into unexposed populations, rapid die-offs of adult and subadult lifestages are observed (Vredenburg *et al.* 2010, p. 9691), with metamorphs being extremely sensitive to Bd infection (Kilpatrick *et al.* 2009, p. 113; Vredenburg *et al.* 2010, p. 9691; see also Vredenburg 2013, unpaginated). Field and laboratory experiments indicate that Bd infection is generally lethal to mountain yellow-legged frogs (Knapp 2005b; Rachowicz 2005, pers. comm.), and is likely responsible for declines in sites that were occupied as recently as 2002, but where frogs were absent by 2005 (Knapp 2005b). Rachowicz *et al.* (2006, p. 1671) monitored several infected and uninfected populations in Sequoia and Kings Canyon National Parks over multiple years, documenting dramatic declines and extirpations in only the infected populations. Rapid die-offs of mountain yellow-legged frogs from chytridiomycosis have been observed in more than 50 water bodies in the southern Sierra Nevada in recent years (Briggs *et al.* 2005, p. 3151). Studies of the microscopic structure of tissue and other evidence suggests Bd caused many of the recent extinctions in the Sierra National Forest's John Muir Wilderness Area and in Kings Canyon National Park, where 41 percent of the populations went extinct between 1995 and 2002 (Knapp 2002a, p. 10).

In several areas where detailed studies of the effects of Bd on the mountain yellow-legged frog are ongoing, substantial declines have been observed following the course of the disease infection and spread. Survey results from 2000 in Yosemite and Sequoia and Kings Canyon National Parks indicated that 17 percent of frog populations in Yosemite and 27 percent of the mountain yellow-legged frog populations sampled across both Sequoia and Kings Canyon National Parks showed evidence of Bd infection,

although the proportion of infected frogs at each site varied greatly and disease incidence varied within each Park (Briggs *et al.* 2002, p. 40) (In the proposed rule, these two figures were averaged across all three parks; these numbers reflect the text presented in Briggs *et al.* 2002). In both 2003 and 2004, 19 percent of the populations that were sampled in Sequoia and Kings Canyon National Parks were infected with Bd (Rachowicz 2005, pp. 2–3). By 2005, 91 percent of assayed populations in Yosemite National Park showed evidence of Bd infection (Knapp 2005b, pp. 1–2), and the number of occupied sites in Sequoia and Kings Canyon National Parks had decreased by 47 percent from those known to be occupied 3 to 8 years previously (Knapp 2005b, pers. comm). Currently, it is believed that all populations in Yosemite Park are infected with Bd (Knapp *et al.* 2011, p. 9).

The effects of Bd on host populations of the mountain yellow-legged frog are variable, ranging from extirpation to persistence with a low level of infection (Briggs *et al.* 2002, pp. 40–41). When Bd infection first occurs in a population, the most common outcome is epidemic spread of the disease and population extirpation (Briggs *et al.* 2010, p. 9699). Die-offs are characterized by rapid onset of high-level Bd infections, followed by death due to chytridiomycosis. Although most populations that are newly exposed to Bd are driven to extirpation following the arrival of Bd, some populations that experience Bd-caused population crashes are not extirpated, and some may even recover despite ongoing chytridiomycosis (Briggs *et al.* 2010, pp. 9695–9696). However, it is apparent that even at sites exhibiting population persistence with Bd, high mortality of

metamorphosing frogs persists, and this phenomenon may explain the lower abundances observed in such populations (Briggs *et al.* 2010, p. 9699).

Vredenburg *et al.* (2010a, pp. 2–4) studied frog populations before, during, and after the infection and spread of Bd in three study basins constituting 13, 33, and 42 frog populations, respectively, then comprising the most intact metapopulations remaining for these species throughout their range. The spread of Bd averaged 688 m/year (yr) (2,257 ft/yr), reaching all areas of the smaller basin in 1 year, and taking 3 to 5 years to completely infect the larger basins, progressing like a wave across the landscape. The researchers documented die-offs following the spread of Bd, with decreased population growth rates evident within the first year of infection. Basinwide, metapopulations crashed from 1,680 to 22 individuals (northern DPS of the mountain yellow-legged frog) in Milestone Basin, with 9 of 13 populations extirpated; from 2,193 to 47 individuals (northern DPS of the mountain yellow-legged frog) in Sixty Lakes Basin, with 27 of 33 populations extirpated; and from 5,588 to 436 individuals (Sierra Nevada yellow-legged frog) in Barrett Lakes Basin, with 33 of 42 populations extirpated. The evidence is clear that Bd can and does decimate newly infected frog populations. Moreover, this rangewide population threat is acting upon a landscape already impacted by habitat modification and degradation by introduced fishes (see Factor A discussion, above). As a result, remnant populations in fishless lakes are now affected by Bd.

Vredenburg *et al.* (2010a, p. 3) projected that, at current extinction rates, and given the disease dynamics of Bd (infected tadpoles succumb to chytridiomycosis at



metamorphosis), most if not all, extant populations within the recently infected basins they studied would go extinct within the next 3 years. Available data (CDFW, unpubl. data; Knapp 2005b; Rachowicz 2005, pers. comm.; Rachowicz *et al.* 2006, p. 1671) indicate that Bd is now widespread throughout the Sierra Nevada and, although it has not infected all populations at this time, it is a serious and substantial threat rangewide to the mountain yellow-legged frog complex.

Other diseases have also been reported as adversely affecting amphibian species, and these may be present within the range of the mountain yellow-legged frog. Bradford (1991, pp. 174–177) reported an outbreak of red-leg disease in Kings Canyon National Park, and suggested this was a result of overcrowding within a mountain yellow-legged frog population. Red-leg disease is caused by the bacterial pathogen *Aeromonas hydrophila*, along with other pathogens. Red-leg disease is opportunistic and successfully attacks immune-suppressed individuals, and this pathogen appears to be highly contagious, affecting the epidermis and digestive tract of otherwise healthy amphibians (Shotts 1984, pp. 51–52; Carey 1993, p. 358; Carey and Bryant 1995, pp. 14–15). Although it has been correlated with decline of a frog population in at least one case, red-leg disease is not thought to be a significant contributor to observed frog population declines rangewide, based on the available literature.

*Saprolegnia* is a globally distributed fungus that commonly attacks all life stages of fishes (especially hatchery-reared fishes), and has recently been documented to attack and kill egg masses of western toads (*Bufo boreas*) (Blaustein *et al.* 1994b, p. 252). This

pathogen may be introduced through fish stocking, or it may already be established in the aquatic ecosystem. Fishes and migrating or dispersing amphibians may be vectors for this fungus (Blaustein *et al.* 1994b, p. 253; Kiesecker *et al.* 2001, p. 1068). *Saprolegnia* has been reported in the southern DPS of the mountain yellow-legged frog (North 2012, pers. comm.); however, its occurrence within the Sierran range of the mountain yellow-legged frog complex and associated influence on population dynamics (if any) are unknown.

Other pathogens of concern for amphibian species include ranaviruses (Family Iridoviridae). Mao *et al.* (1999, pp. 49–50) isolated identical iridoviruses from co-occurring populations of the threespine stickleback (*Gasterosteus aculeatus*) and the red-legged frog (*Rana aurora*), indicating that infection by a given virus is not limited to a single species, and that iridoviruses can infect animals of different taxonomic classes. This suggests that virus-hosting trout introduced into mountain yellow-legged frog habitat may be a vector for amphibian viruses. However, definitive mechanisms for the transmission to the mountain yellow-legged frog remain unknown. No viruses were detected in the mountain yellow-legged frogs that Fellers *et al.* (2001, p. 950) analyzed for Bd. In Kings Canyon National Park, Knapp (2002a, p. 20) found mountain yellow-legged frogs showing symptoms attributed to a ranavirus (Knapp 2013, unpaginated). To date, ranaviruses remain a concern for the mountain yellow-legged frog complex, but the available information does not indicate they are negatively affecting populations.

It is unknown whether amphibian pathogens in the high Sierra Nevada have always coexisted with amphibian populations or if the presence of such pathogens is a recent phenomenon. However, it has been suggested that the susceptibility of amphibians to pathogens may have recently increased in response to anthropogenic environmental disruption (Carey 1993, pp. 355–360; Blaustein *et al.* 1994b, p. 253; Carey *et al.* 1999, p. 7). This hypothesis suggests that environmental changes may be indirectly responsible for certain amphibian die-offs due to immune system suppression of tadpoles or post-metamorphic amphibians (Carey 1993, p. 358; Blaustein *et al.* 1994b, p. 253; Carey *et al.* 1999, pp. 7–8). Pathogens such as *Aeromonas hydrophila*, which are present in fresh water and in healthy organisms, may become more of a threat, potentially causing localized amphibian population die-offs when the immune systems of individuals within the host population are suppressed (Carey 1993, p. 358; Carey and Bryant 1995, p. 14).

The contribution of Bd as an environmental stressor and limiting factor on mountain yellow-legged frog population dynamics is currently extremely high, and it poses a significant current and continuing threat to remnant uninfected populations in the southern Sierra Nevada. Its effects are most dramatic following the epidemic stage as it spreads across newly infected habitats; massive die-off events follow the spread of the fungus, and it is likely that survival of mountain yellow-legged frogs through the metamorphosis stage is substantially reduced even years after the initial epidemic (Rachowicz *et al.* 2006, pp. 1679–1680). The relative impact from other diseases and the interaction of other stressors and disease on the immune systems of mountain yellow-legged frogs remains poorly documented to date.

In summary, based on the best available scientific and commercial information, we consider the threats of predation and disease to be significant, ongoing threats to the Sierra Nevada yellow-legged frog and the northern DPS of the mountain yellow-legged frog. These threats include predation by bullfrogs and introduced fishes, and amphibian pathogens (most specifically, the chytrid fungus), two primary driving forces leading to population declines in the mountain yellow-legged frog complex. These are highly prevalent threats, and they are predominant limiting factors hindering population viability and precluding recovery across the ranges of the mountain yellow-legged frog complex.

*Factor D. The Inadequacy of Existing Regulatory Mechanisms*

In determining whether the inadequacy of regulatory mechanisms constitutes a threat to the mountain yellow-legged frog complex, we analyzed the existing Federal and State laws and regulations that may address the threats to these species or contain relevant protective measures. Regulatory mechanisms are typically nondiscretionary and enforceable, and may preclude the need for listing if such mechanisms are judged to adequately address the threat(s) to the species such that listing is not warranted. Conversely, threats on the landscape are not ameliorated where existing regulatory mechanisms are not adequate (or when existing mechanisms are not adequately implemented or enforced).

Federal

### *Wilderness Act*

The Wilderness Act of 1964 (16 U.S.C. 1131 *et seq.*) established a National Wilderness Preservation System made up of federally owned areas designated by Congress as “wilderness” for the purpose of preserving and protecting designated areas in their natural condition. The Wilderness Act states the use of these areas with limited exception are subject to the following restrictions: (1) New or temporary roads cannot be built; (2) motor vehicles, motorized equipment, or motorboats cannot be used; (3) aircraft cannot land; (4) no form of mechanical transport can occur; and (5) no structure or installation may be built. In addition, a special provision within the Wilderness Act stipulated that, except for valid existing rights, effective January 1, 1984, the minerals within designated wilderness areas would be withdrawn from all forms of appropriation under mining laws, precluding new mining claims within designated wilderness after that date (see Hendee *et al.* 1990, p. 508). A large number of mountain yellow-legged frog locations occur within wilderness areas managed by the USFS and NPS and, therefore, are afforded protection from direct loss or degradation of habitat by some human activities (such as development, commercial timber harvest, road construction, and some fire management actions). Livestock grazing and fish stocking both occur within designated wilderness areas on lands within the National Forest System.

### *National Forest Management Act of 1976*

Under the National Forest Management Act of 1976, as amended (NFMA) (16 U.S.C. 1600 *et seq.*), the USFS is tasked with managing National Forest lands based on multiple-use, sustained-yield principles, and with implementing land and resource management plans (LRMP) on each National Forest to provide for a diversity of plant and animal communities. The purpose of an LRMP is to guide and set standards for all natural resource management activities for the life of the plan (10 to 15 years). NFMA requires the USFS to incorporate standards and guidelines into LRMPs. The 1982 planning regulations for implementing NFMA (47 FR 43026; September 30, 1982), under which all existing forest plans in the Sierra Nevada were prepared until recently, guided management of National Forests and required that fish and wildlife habitat on National Forest system lands be managed to maintain viable populations of existing native and desired nonnative vertebrate species in the planning area. A viable population is defined as a population of a species that continues to persist over the long term with sufficient distribution to be resilient and adaptable to stressors and likely future environments. In order to insure that viable populations would be maintained, the 1982 planning regulations directed that habitat must be provided to support, at least, a minimum number of reproductive individuals and that habitat must be well-distributed so that those individuals could interact with others in the planning area.

On April 9, 2012, the USFS published a final rule (77 FR 21162) amending 36 CFR 219 to adopt new National Forest System land management regulations that guide the development, amendment, and revision of LRMPs for all Forest System lands. These revised regulations, which became effective on May 9, 2012, replaced the 1982 planning

rule. The 2012 planning rule requires that the USFS maintain viable populations of species of conservation concern at the discretion of regional foresters. This rule could thereby result in removal of the limited protections that are currently in place for mountain yellow-legged frogs under the Sierra Nevada Forest Plan Amendment (SNFPA), as described below.

### *Sierra Nevada Forest Plan Amendment*

In 2001, a record of decision was signed by the USFS for the Sierra Nevada Forest Plan Amendment (SNFPA), based on the final environmental impact statement for the SNFPA effort and prepared under the 1982 NFMA planning regulations. The Record of Decision amends the USFS Pacific Southwest Regional Guide, the Intermountain Regional Guide, and the LRMPs for National Forests in the Sierra Nevada and Modoc Plateau. This document affects land management on all National Forests throughout the range of the mountain yellow-legged frog complex. The SNFPA addresses and gives management direction on issues pertaining to old forest ecosystems; aquatic, riparian, and meadow ecosystems; fire and fuels; noxious weeds; and lower west-side hardwood ecosystems of the Sierra Nevada. In January 2004, the USFS amended the SNFPA, based on the final supplemental environmental impact statement, following a review of fire and fuels treatments, compatibility with the National Fire Plan, compatibility with the Herger-Feinstein Quincy Library Group Forest Recovery Pilot Project, and effects of the SNFPA on grazing, recreation, and local communities (USDA 2004, pp. 26–30).

Relevant to the mountain yellow-legged frog complex, the Record of Decision for SNFPA aims to protect and restore aquatic, riparian, and meadow ecosystems, and to provide for the viability of associated native species through implementation of an aquatic management strategy. The aquatic management strategy is a general framework with broad policy direction. Implementation of this strategy was intended to take place at the landscape and project levels. Nine goals are associated with the aquatic management strategy:

(1) The maintenance and restoration of water quality to comply with the Clean Water Act (CWA) and the Safe Drinking Water Act;

(2) The maintenance and restoration of habitat to support viable populations of native and desired nonnative riparian-dependent species, and to reduce negative impacts of nonnative species on native populations;

(3) The maintenance and restoration of species diversity in riparian areas, wetlands, and meadows to provide desired habitats and ecological functions;

(4) The maintenance and restoration of the distribution and function of biotic communities and biological diversity in special aquatic habitats (such as springs, seeps, vernal pools, fens, bogs, and marshes);

(5) The maintenance and restoration of spatial and temporal connectivity for aquatic and riparian species within and between watersheds to provide physically, chemically, and biologically unobstructed movement for their survival, migration, and reproduction;



(6) The maintenance and restoration of hydrologic connectivity between floodplains, channels, and water tables to distribute flood flows and to sustain diverse habitats;

(7) The maintenance and restoration of watershed conditions as measured by favorable infiltration characteristics of soils and diverse vegetation cover to absorb and filter precipitation, and to sustain favorable conditions of streamflows;

(8) The maintenance and restoration of instream flows sufficient to sustain desired conditions of riparian, aquatic, wetland, and meadow habitats, and to keep sediment regimes within the natural range of variability; and

(9) The maintenance and restoration of the physical structure and condition of streambanks and shorelines to minimize erosion and sustain desired habitat diversity.

If these goals of the aquatic management strategy are pursued and met, threats to the mountain yellow-legged frog complex resulting from habitat alterations could be reduced. However, the aquatic management strategy is a generalized approach that does not contain specific implementation timeframes or objectives, and it does not provide direct protections for the mountain yellow-legged frog. Additionally, as described above, the April 9, 2012, final rule (77 FR 21162) that amended 36 CFR 219 to adopt new National Forest System land management planning regulations could result in removal of the limited protections that are currently in place for mountain yellow-legged frogs under the SNFPA.

*National Park Service Organic Act*

The statute establishing the National Park Service, commonly referred to as the National Park Service Organic Act (39 Stat. 535; 16 U.S.C. 1, 2, 3, and 4), states that the NPS will administer areas under their jurisdiction “...by such means and measures as conform to the fundamental purpose of said parks, monuments, and reservations, which purpose is to conserve the scenery and the natural and historic objects and the wildlife therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations.” Park managers must take action to ensure that ongoing NPS activities do not cause impairment. In cases of doubt as to the impact of activities on park natural resource, the Park Service is to decide in favor of protecting the natural resources. Sequoia, Kings Canyon, and Yosemite National Parks began phasing out fish stocking by the State in 1969 and terminated this practice entirely in 1991 (Knapp 1996, p. 9)

#### *Federal Power Act*

The Federal Power Act of 1920, as amended (FPA) (16 U.S.C. 791 *et seq.*) was enacted to regulate non-federal hydroelectric projects to support the development of rivers for energy generation and other beneficial uses. The FPA provides for cooperation between the Federal Energy Regulatory Commission (Commission) and other Federal agencies in licensing and relicensing power projects. The FPA mandates that each license includes conditions to protect, mitigate, and enhance fish and wildlife and their habitat affected by the project. However, the FPA also requires that the Commission give equal consideration to competing priorities, such as power and development, energy

conservation, protection of recreational opportunities, and preservation of other aspects of environmental quality. Further, the FPA does not mandate protections of habitat or enhancements for fish and wildlife species, but provides a mechanism for resource agency recommendations that are incorporated into a license at the discretion of the Commission. Additionally, the FPA provides for the issuance of a license for the duration of up to 50 years, and the FPA contains no provision for modification of the project for the benefit of species, such as mountain yellow-legged frogs, before a current license expires.

Although most reservoirs and water diversions are located at lower elevations than those at which extant mountain yellow-legged frog populations occur, numerous extant populations occur within watersheds that feed into developed and managed aquatic systems (such as reservoirs and water diversions) operated for the purpose of power generation and regulated by the FPA and may be considered during project relicensing.

State

#### *California Endangered Species Act*

This section has been updated from the information presented in the proposed rule, and discussion of CDFW's current fish-stocking practices has been moved to the Factor A discussion of Habitat Modification Due to Introduction of Trout to Historically Fishless Areas.

The California Endangered Species Act (CESA) (California Fish and Game Code, section 2080 *et seq.*) prohibits the unauthorized take of State-listed endangered or threatened species. CESA requires State agencies to consult with CDFW on activities that may affect a State-listed species, and mitigate for any adverse impacts to the species or its habitat. Pursuant to CESA, it is unlawful to import or export, take, possess, purchase, or sell any species or part or product of any species listed as endangered or threatened. The State may authorize permits for scientific, educational, or management purposes, and allow take that is incidental to otherwise lawful activities. On April 1, 2013, the Sierra Nevada yellow-legged frog was listed as a threatened species and the mountain yellow-legged frog (Statewide) was listed as an endangered species under CESA (CDFW 2013, p. 1).

While the listing of the Sierra Nevada yellow-legged frog and the mountain yellow-legged frog under CESA provide some protections to these species, as State regulation prohibits the unauthorized take of State-listed species, the definition of take under CESA does not include habitat modification or degradation. Additionally, the majority of the lands occupied by these species are federally managed lands, so there is limited jurisdiction in which to regulate land management activities that may affect these species.

Overall, existing Federal and State laws and regulatory mechanisms currently offer some level of protection for the mountain yellow-legged frog complex. While not

the intent of the Wilderness Act, the mountain yellow-legged frogs receive ancillary protection from the Wilderness Act due to its prohibitions on development, road construction, and timber harvest, and associated standards and guidelines that limit visitor and packstock group sizes and use. With the exception of the National Park Service Organic Act, the existing regulatory mechanisms have not been effective in reducing threats to mountain yellow-legged frogs and their habitat from fish stocking and the continuing presence of nonnative fish. Nor have these mechanisms been effective in protecting populations from infection by diseases, although Forest Service standards and guidelines have likely reduced threats associated with grazing, timber harvest, and recreation use. Although State regulations under CESA provide some protection against take of the mountain yellow-legged frogs, the definition of take under CESA does not include habitat modification or degradation.

*Factor E. Other Natural or Manmade Factors Affecting Its Continued Existence*

The mountain yellow-legged frog is sensitive to environmental change or degradation because it has an aquatic and terrestrial life history and highly permeable skin that increases exposure of individuals to substances in the water, air, and terrestrial substrates (Blaustein and Wake 1990, p. 203; Bradford and Gordon 1992, p. 9; Blaustein and Wake 1995, p. 52; Stebbins and Cohen 1995, pp. 227–228). Several natural or anthropogenically influenced changes, including contaminant deposition, acid precipitation, increases in ambient ultraviolet radiation, and climate change, have been implicated as contributing to amphibian declines (Corn 1994, pp. 62–63; Alford and

Richards 1999, pp. 2–7). There are also documented incidences of direct mortality of, or the potential for direct disturbance to, individuals from some activities already discussed; in severe instances, these actions may have population-level consequences. As presented in the proposed rule (78 FR 24472, April 25, 2013), contaminants, acid precipitation, and ambient ultraviolet radiation are not known to pose a threat (current or historical) to the mountain yellow-legged frog and, therefore, are not discussed further. Please refer to the proposed listing rule for the Sierra Nevada yellow-legged frog, the northern DPS of the mountain yellow-legged frog, and the Yosemite toad (78 FR 24472, April 25, 2013) for a detailed discussion of contaminants, acid precipitation, and ambient ultraviolet radiation.

## Climate Change

Our analysis under the Act includes consideration of ongoing and projected changes in climate. The terms “climate” and “climate change” are defined by the Intergovernmental Panel on Climate Change (IPCC). The term “climate” refers to the mean and variability of different types of weather conditions over time, with 30 years being a typical period for such measurements, although shorter or longer periods also may be used (IPCC 2007a, p. 1450; IPCC 2013a, Annex III). The term “climate change” thus refers to a change in the mean or variability of one or more measures of climate (for example, temperature or precipitation) that persists for an extended period, typically decades or longer, whether the change is due to natural variability, human activity, or both (IPCC 2007a, p. 1450; IPCC 2013a, Annex III). A recent compilation of climate

change and its effects is available from reports of the Intergovernmental Panel on Climate Change (IPCC) (IPCC 2013b, entire).

Global climate projections are informative and, in some cases, the only or the best scientific information available for us to use. However, projected changes in climate and related impacts can vary substantially across and within different regions of the world (for example, IPCC 2007a, pp. 8–12). Therefore, we use downscaled projections when they are available and have been developed through appropriate scientific procedures, because such projections provide higher resolution information that is more relevant to the spatial scales used for analyses of a given species (see Glick *et al.* 2011, pp. 58–61, for a discussion of downscaling). With regard to our analysis for the Sierra Nevada of California (and western United States), downscaled projections are available, yet even downscaled climate models contain some uncertainty.

Variability exists in outputs from different climate models, and uncertainty regarding future GHG emissions is also a factor in modeling (PRBO 2011, p. 3). A general pattern that holds for many predictive models indicates northern areas of the United States will become wetter, and southern areas (particularly the Southwest) will become drier. These models also predict that extreme events, such as heavier storms, heat waves, and regional droughts, may become more frequent (Glick *et al.* 2011, p. 7). Moreover, it is generally expected that the duration and intensity of droughts will increase in the future (Glick *et al.* 2011, p. 45; PRBO 2011, p. 21).

The last century has included some of the most variable climate reversals documented, at both the annual and near-decadal scales, including a high frequency of El Niño (associated with more severe winters) and La Niña (associated with milder winters) events (reflecting drought periods of 5 to 8 years alternating with wet periods) (USDA 2001b, p. 33). Scientists have confirmed a longer duration climate cycle termed the Pacific Decadal Oscillation (PDO), which operates on cycles between 2 to 3 decades, and generally is characterized by warm and dry (PDO positive) followed by cool and wet cycles (PDO negative) (Mantua *et al.* 1997, pp. 1069–1079; Zhang *et al.* 1997, pp. 1004–1018). Snowpack is seen to follow this pattern—heavier in the PDO negative phase in California, and lighter in the positive phase (Mantua *et al.* 1997, p. 14; Cayan *et al.* 1998, p. 3148; McCabe and Dettinger 2002, p. 24).

For the Sierra Nevada ecoregion, climate models predict that mean annual temperatures will increase by 1.8 to 2.4 °C (3.2 to 4.3 °F) by 2070, including warmer winters with earlier spring snowmelt and higher summer temperatures. However, it is expected that temperature and climate variability will vary based on topographic diversity (for example, wind intensity will determine east versus west slope variability) (PRBO 2011, p. 18). Mean annual rainfall is projected to decrease from 9.2–33.9 cm (3.6–13.3 in) by 2070; however, projections have high uncertainty and one study predicts the opposite effect (PRBO 2011, p. 18). Given the varied outputs from differing modeling assumptions, and the influence of complex topography on microclimate patterns, it is difficult to draw general conclusions about the effects of climate change on precipitation patterns in the Sierra Nevada (PRBO 2011, p. 18). Snowpack is, by all projections, going



to decrease dramatically (following the temperature rise and more precipitation falling as rain) (Kadir *et al.* 2013, pp. 76–80). Higher winter streamflows, earlier runoff, and reduced spring and summer streamflows are projected, with increasing severity in the southern Sierra Nevada (PRBO 2011, pp. 20–22); (Kadir *et al.* 2013, pp. 71–75).

Snow-dominated elevations of 2,000–2,800 m (6,560–9,190 ft) will be the most sensitive to temperature increases, and a warming of 5 °C (9 °F) is projected to shift center timing (the measure when half a stream’s annual flow has passed a given point in time) to more than 45 days earlier in the year as compared to the 1961–1990 baseline (PRBO 2011, p. 23). Lakes, ponds, and other standing waters fed by snowmelt or streams are likely to dry out or be more ephemeral during the non-winter months (Lacan *et al.* 2008, pp. 216–222; PRBO 2011, p. 24). This pattern could influence ground water transport, and springs may be similarly depleted, leading to lower lake levels.

Blaustein *et al.* (2010, pp. 285–300) provide an exhaustive review of potential direct and indirect and habitat-related effects of climate change to amphibian species, with documentation of effects in a number of species where such effects have been studied. Altitudinal range shifts with changes in climate have been reported in some regions. They note that temperature can influence the concentration of dissolved oxygen in aquatic habitats, with warmer water generally having lower concentrations of dissolved oxygen, and that water balance heavily influences amphibian physiology and behavior. They predict that projected changes in temperature and precipitation are likely to increase

habitat loss and alteration for those species living in sensitive habitats, such as ephemeral ponds and alpine habitats (Blaustein *et al.* 2010, pp. 285–287).

Because environmental cues such as temperature and precipitation are clearly linked to onset of reproduction in many species, climate change will likely affect the timing of reproduction in many species, potentially with different sexes responding differently to climate change. For example, males of two newt species (*Triturus* spp.) showed a greater degree of change in arrival date at breeding ponds (Blaustein *et al.* 2010, p. 288). Lower concentrations of dissolved oxygen in aquatic habitats may negatively affect developing embryos and larvae, in part because increases in temperature increase the oxygen consumption rate in amphibians. Reduced oxygen concentrations have also been shown to result in accelerated hatching in ranid frogs, but at a smaller size, while larval development and behavior may also be affected and may be mediated by larval density and food availability (Blaustein *et al.* 2010, pp. 288–289).

Increased temperatures can reduce time to metamorphosis, which can increase chances of survival where ponds dry, but also result in metamorphosis at a smaller size, suggesting a likely trade-off between development and growth, which may be exacerbated by climate change and have fitness consequences for adults (Blaustein *et al.* 2010, pp. 289–290). Changes in terrestrial habitat, such as changed soil moisture and vegetation, can also directly affect adult and juvenile amphibians, especially those adapted to moist forest floors and cool, highly oxygenated water that characterizes montane regions. Climate change may also interact with other stressors that may be

acting on a particular species, such as disease and contaminants (Blaustein *et al.* 2010, pp. 290–299).

A recent paper (Kadir *et al.* 2013, entire) provides specific information on the effects of climate change in the Sierra Nevada. The report found that glaciers in the Sierra Nevada have decreased in area over the past century, and glacier shrinkage results in earlier peak water runoff and drier summer conditions. Another result from the report is that the lower edge of the conifer-dominated forests in the Sierra Nevada has been retreating upslope over the past 60 years. Regarding wildfire, since 1950, annual acreage burned in wildfires statewide has been increasing in California, and in the western United States, large wildfires have become more frequent, increasing in tandem with rising spring and summer temperatures. Finally, the report found that today's subalpine forests in the Sierra Nevada are much denser—that is, comprise more small-diameter trees—than they were over 70 years ago. During this time period, warmer temperatures, earlier snowmelt, and more rain than snow occurred in this region. Many of these changes in the Sierra Nevada of California due to climate are likely to influence mountain yellow-legged frogs because both mountain yellow-legged frog species in the Sierra Nevada are highly vulnerable to climate change because changing hydrology and habitat in the Sierra Nevada will likely have impacts on remaining populations (Viers *et al.* 2013, pp. 55, 56).

Vulnerability of species to climate change is a function of three factors: Sensitivity of a species or its habitat to climate change, exposure of individuals to such physical changes in the environment, and their capacity to adapt to those changes (Glick

*et al.* 2011, pp. 19–22). Critical sensitivity elements broadly applicable across organizational levels (from species through habitats to ecosystems) are associated with physical variables, such as hydrology (timing, magnitude, and volume of waterflows), fire regime (frequency, extent, and severity of fires), and wind (Glick *et al.* 2011, pp. 39–40). Species-level sensitivities generally include physiological factors, such as changes in temperature, moisture, or pH as they influence individuals; these also include dependence on sensitive habitats, ecological linkages to other species, and changes in phenology (timing of key life-history events) (Glick *et al.* 2011, pp. 40–41).

Exposure to environmental stressors renders species vulnerable to climate change impacts, either through direct mechanisms (for example, physical temperature extremes or changes in solar radiation), or indirectly through impacts upon habitat (hydrology; fire regime; or abundance and distribution of prey, competitors, or predator species). A species' capacity to adapt to climate change is increased by behavioral plasticity (the ability to modify behavior to mitigate the impacts of the stressor), dispersal ability (the ability to relocate to meet shifting conditions), and evolutionary potential (for example, shorter lived species with multiple generations have more capacity to adapt through evolution) (Glick *et al.* 2011, pp. 48–49).

The International Union for Conservation of Nature describes five categories of life-history traits that render species more vulnerable to climate change (Foden *et al.* 2008 in Glick *et al.* 2011, p. 33): (1) Specialized habitat or microhabitat requirements, (2) narrow environmental tolerances or thresholds that are likely to be exceeded under

climate change, (3) dependence on specific triggers or cues that are likely to be disrupted (for example, rainfall or temperature cues for breeding, migration, or hibernation), (4) dependence on interactions between species that are likely to be disrupted, and (5) inability or poor ability to disperse quickly or to colonize more suitable range. We apply these criteria in this final rule to assess the vulnerability of mountain yellow-legged frogs to climate change.

At high elevations, where most extant populations occur, mountain yellow-legged frogs depend on high mountain lakes where both adult and larval frogs overwinter under ice for up to 9 months of the year. Overwintering under ice poses physiological problems for the frogs, most notably the depletion of oxygen in the water during the winter (Bradford 1983, p. 1171). Bradford (1983, pp. 1174–1182) has found, based on lab and field results, that tadpoles are more resistant to low dissolved oxygen levels than adult frogs; after two drought years that were followed by a severe winter, all frogs in 21 of 26 study lakes were lost (with the exception of one 2.1-m (6.9-ft) deep lake that contained only one individual), while tadpoles survived in all but one of the shallowest lakes. Losses were apparently due to oxygen depletion in a year when there was exceptional precipitation, ice depths that were thicker than usual, and lake thawing was 5 to 6 weeks later than the previous year. The survival of adults in substantial numbers was significantly correlated with lake depth and confined to lakes deeper than 4 m (13.1 ft).

Bradford (1983, pp. 1174–1179) found that mean oxygen concentration in lakes was directly related to maximum lake depth, with dissolved oxygen levels declining

throughout the winter. He also found that a thickened ice layer on a lake causes the lake to become effectively more shallow, leading to an increased rate of oxygen depletion (Bradford 1983, p. 1178). Studies of winterkill of fish due to oxygen depletion also show that oxygen depletion is inversely related to lake depth and occurs most rapidly in shallow lakes relative to deeper lakes (See review in Bradford 1983, p. 1179). Bradford (1983, p. 1179) considered the possibility that winterkill of the frogs was due to freezing, but dismissed the potential because some of the lakes where winterkill occurred were deeper than the probable maximum ice depth in that year. Because the deeper lakes that once supported frog populations now harbor introduced trout populations and are generally no longer available as refugia for frogs, the shallower lakes where frogs currently occur may be more vulnerable to weather extremes in a climate with increased variability, including drought years and years with exceptional severe cold winters. Such episodic stressors may have been infrequent in the past, but appear to be increasing, and they are important to long-lived species with small populations.

In summer, reduced snowpack and enhanced evapotranspiration following higher temperatures can dry out ponds that otherwise would have sustained rearing tadpoles (Lacan *et al.* 2008, p. 220), and may also reduce fecundity (egg production) (Lacan *et al.* 2008, p. 222). Lacan *et al.* (2008, p. 211) observed that most frog breeding occurred in the smaller, fishless lakes of Kings Canyon National Park that are shallow and prone to summer drying. Thus, climate change will likely reduce available breeding habitat for mountain yellow-legged frogs and lead to greater frequency of stranding and death of

tadpoles as such lakes dry out earlier in the year (Corn 2005, p. 64; Lacan *et al.* 2008, p. 222).

Earlier snowmelt is expected to cue breeding earlier in the year. The advance of this primary signal for breeding phenology in montane and boreal habitats (Corn 2005, p. 61) may have both positive and negative effects. Additional time for growth and development may render larger individuals more fit to overwinter; however, earlier breeding may also expose young tadpoles (or eggs) to killing frosts in more variable conditions of early spring (Corn 2005, p. 60).

Whether mountain yellow-legged frogs depend on other species that may be affected either positively or negatively by climate change is unclear. Climate change may alter invertebrate communities (PRBO 2011 p. 24). In one study, an experimental increase in stream temperature was shown to decrease density and biomass of invertebrates (Hogg and Williams 1996, p. 401). Thus, climate change might have a negative impact on the mountain yellow-legged frog prey base.

Indirect effects from climate change may lead to greater risk to mountain yellow-legged frog population persistence. For example, fire intensity and magnitude are projected to increase (PRBO 2011, pp. 24–25), and, therefore, the contribution and influence of this stressor upon frog habitat and populations will increase. Climate change may alter lake productivity through changes in water chemistry, the extent and timing of mixing, and nutrient inputs from increased fires, all of which may influence community

dynamics and composition (Melack *et al.* 1997, p. 971; Parker *et al.* 2008, p. 12927).

These changes may not all be negative; for example, water chemistry and nutrient inputs, along with warmer summer temperatures, could increase net primary productivity in high mountain lakes to enhance frog food sources, although changes in net primary productivity may also negatively affect invertebrate prey species endemic to oligotrophic lakes (low nutrient, low productivity).

Carey (1993, p. 359) has suggested that, where environmental changes cause sufficient stress to cause immunological suppression, cold body temperatures that montane amphibians experience over winter could play a synergistic role in reducing further immunological responses to disease. Thus, such conditions might make mountain yellow-legged frogs more susceptible to disease. Additionally, Blaustein *et al.* (2001, p. 1808) have suggested that climate change could also affect the distribution of pathogens and their vectors, exposing amphibians to new pathogens. Climate change (warming) has been hypothesized as a driver for the range shift of Bd (Pounds *et al.* 2006, p. 161; Bosch *et al.* 2007, p. 253). However, other work has indicated that survival and transmission of Bd is more likely facilitated by cooler and wetter conditions (Corn 2005, p. 63). Fisher *et al.* (2009, p. 299) present a review of information available to date and evaluate the competing hypotheses regarding Bd dynamics, and they present some cases that suggest a changing climate can change the host–pathogen dynamic to a more virulent state.

The key risk factor for climate change impacts on mountain yellow-legged frogs is likely the combined effect of reduced water levels in high mountain lakes and ponds



and the relative inability of individuals to disperse and colonize across longer distances in order to occupy more favorable habitat conditions (if they exist). Although such adaptive range shifts have been observed in some plant and animal species, they have not been reported in amphibians. The changes observed in amphibians to date have been more associated with changes in timing of breeding (phenology) (Corn 2005, p. 60). This limited adaptive capacity for mountain yellow-legged frogs is a function of high site fidelity and the extensive habitat fragmentation due to the introduction of fishes in many of the more productive and persistent high mountain lake habitats and streams that constitute critical dispersal corridors throughout much of the frogs' range (see Factor C discussion above).

An increase in the frequency, intensity, and duration of droughts caused by climate change may have compounding effects on populations of mountain yellow-legged frogs already in decline. In situations where other stressors (such as introduced fish) have resulted in the isolation of mountain yellow-legged frogs in marginal habitats, localized mountain yellow-legged frog population crashes or extirpations resulting from drought may exacerbate their isolation and preclude natural recolonization (Bradford *et al.* 1993, p. 887; Drost and Fellers 1996, p. 424; Lacan *et al.* 2008, p. 222). Viers *et al.* (2013, pp. 55, 56) have used a variety of risk metrics to determine that both mountain yellow-legged frog species in the Sierra Nevada are highly vulnerable to climate change, and that changing hydrology and habitat in the Sierra Nevada will likely have drastic impacts on remaining populations. Climate change represents a substantial future threat to the persistence of mountain yellow-legged frog populations.

## Direct and Indirect Mortality

Other risk factors include direct and indirect mortality as an unintentional consequence of activities within mountain yellow-legged frog habitat. Mortality due to trampling by grazing livestock has been noted in a limited number of situations, with expected mortality risk thought to be greatest if livestock concentrate in prime breeding habitat early in the season when adults are breeding and egg masses are present (Brown *et al.* 2009, p. 59). Brown *et al.* (2009, p. 59) note that standards in the SNFPA are intended to mitigate this risk. Recreational uses also have the potential to result in direct or indirect mortality of mountain yellow-legged frog individuals at all life stages. The Forest Service has identified activities, including recreational activities that occur in the frogs' breeding sites as being risk factors for the frogs, while noting that recreation use is a risk that USFS management can change (USDA 2001a, pp. 213–214). Brown *et al.* (2009, pp. 65–66) note that tadpoles and juveniles, in particular, may be injured or killed by trampling, crushing, etc., by hikers, bikers, anglers, pets, packstock, or off-highway vehicles, although the number of documented situations appears limited. Recreational activities, such as hiking and camping, are associated primarily with physical site alteration (changes to soil and vegetation conditions), and such effects are found to be highly localized. For example, estimates in a heavily-used portion of the Eagle Cap Wilderness in Oregon indicated that no more than 2 percent of the area had been altered by recreational use (Cole and Landres 1996, p. 170). However, where impacts of recreational use are highly localized, species impacts due to trampling have been

identified, especially for rare plant species (Cole and Landres 1996, p. 170). Fire management activities (i.e. fuels reduction and prescribed fire) lead to some direct mortality and have the potential to disrupt behavior. Please refer to the proposed listing rule for the Sierra Nevada yellow-legged frog and the northern DPS of the mountain yellow-legged frog under the Act (16 U.S.C. 1531 *et seq.*) for information about effects of fire retardants on mountain yellow-legged frogs. Roads create the potential for direct mortality of amphibians by vehicle strikes (deMaynadier and Hunter 2000, p. 56) and the possible introduction of contaminants into new areas; however, most extant populations are not located near roads. Collectively, direct mortality risks to mountain yellow-legged frogs are likely of sporadic significance. They may be important on occasion on a site-specific basis, but are likely of low prevalence across the range of the species.

#### Small Population Size

In many localities, remaining populations for both the Sierra Nevada yellow-legged frog and the mountain yellow-legged frog are small (CDFW, unpubl. data). Brown *et al.* (2011, p. 24) reported that about 90 percent of watersheds have fewer than 10 adults and 80 percent have fewer than 10 subadults and 100 tadpoles. Remnant populations in the northern portion of the range for the Sierra Nevada yellow-legged frog (from Lake Tahoe north) and the southern portion of the populations of the northern DPS of the mountain yellow-legged frog (south of Kings Canyon National Park) currently also exhibit very low abundances (CDFW, unpubl. data).

Compared to large populations, small populations are more vulnerable to extirpation from environmental, demographic, and genetic stochasticity (random natural occurrences), and unforeseen (natural or unnatural) catastrophes (Shaffer 1981, p. 131). Environmental stochasticity refers to annual variation in birth and death rates in response to weather, disease, competition, predation, or other factors external to the population (Shaffer 1981, p. 131). Small populations may be less able to respond to natural environmental changes (Kéry *et al.* 2000, p. 28), such as a prolonged drought or even a significant natural predation event. Periods of prolonged drought are more likely to have a significant effect on mountain yellow-legged frogs because drought conditions occur on a landscape scale and all life stages are dependent on habitat with suitable perennial water. Demographic stochasticity is random variability in survival or reproduction among individuals within a population (Shaffer 1981, p. 131) and could increase the risk of extirpation of the smaller remaining populations. Genetic stochasticity results from changes in gene frequencies due to the founder effect (loss of genetic variation that occurs when a new population is established by a small number of individuals) (Reiger 1968, p. 163); random fixation (the complete loss of one of two alleles in a population, the other allele reaching a frequency of 100 percent) (Reiger 1968, p. 371); or inbreeding depression (loss of fitness or vigor due to mating among relatives) (Soulé 1980, p. 96). Additionally, small populations generally have an increased chance of genetic drift (random changes in gene frequencies from generation to generation that can lead to a loss of variation) and inbreeding (Ellstrand and Elam 1993, p. 225).

Allee effects (Dennis 1989, pp. 481–538) occur when a population loses its positive stock-recruitment relationship (when population is in decline). In a declining population, an extinction threshold or “Allee threshold” (Berec *et al.* 2006, pp. 185–191) may be crossed, where adults in the population either cease to breed or the population becomes so compromised that breeding does not contribute to population growth. Allee effects typically fall into three broad categories (Courchamp *et al.* 1999, pp. 405–410): lack of facilitation (including low mate detection and loss of breeding cues), demographic stochasticity, and loss of heterozygosity (a measure of genetic variability). Environmental stochasticity amplifies Allee effects (Dennis 1989, pp. 481–538; Dennis 2002, pp. 389–401). The Allee effects of demographic stochasticity and loss of heterozygosity are likely as mountain yellow-legged frog populations continue to diminish.

The extinction risk for a species represented by few small populations is magnified when those populations are isolated from one another. This is especially true for species whose populations normally function in a metapopulation structure, whereby dispersal or migration of individuals to new or formerly occupied areas is necessary. Connectivity between these populations is essential to increase the number of reproductively active individuals in a population; mitigate the genetic, demographic, and environmental effects of small population size; and recolonize extirpated areas. Additionally, fewer populations by itself increases the risk of extinction.

The combination of low numbers with the other extant stressors of disease, fish persistence, and potential for climate extremes could have adverse consequences for the mountain yellow-legged frog complex as populations approach the Allee threshold. Small population size is currently a significant threat to most populations of mountain yellow-legged frogs across the range of the species.

### Cumulative Impacts of Extant Threats

Stressors may act additively or synergistically. An additive effect would mean that an accumulation of otherwise low threat factors acting in combination may collectively result in individual losses that are meaningful at the population level. A synergistic effect is one where the interaction of one or more stressors together leads to effects greater than the sum of those individual factors combined. Further, the cumulative effect of multiple added stressors can erode population viability over successive generations and act as a chronic strain on the viability of a species, resulting in a progressive loss of populations over time. Such interactive effects from compounded stressors thereby act synergistically to curtail the viability of frog metapopulations and increase the risks of extinction.

It is difficult to predict the precise impact of the cumulative threat represented by the relatively novel Bd epidemic across a landscape already fragmented by fish stocking. The singular threat of the Bd epidemic wave in the uninfected populations of the mountain yellow-legged frog complex in the southern Sierra Nevada could extirpate

those populations as the pathogen spreads. A compounding effect of disease-caused extirpation is that recolonization may never occur because streams connecting extirpated sites to extant populations now contain introduced fishes, which act as barriers to frog movement within metapopulations. This situation isolates the remaining populations of mountain yellow-legged frogs from one another (Bradford 1991, p. 176; Bradford *et al.* 1993, p. 887). It is logical to presume that the small, fragmented populations left in the recent wake of Bd spread through the majority of the range of the Sierra Nevada yellow-legged frog may experience further extirpations as surviving adults eventually die, and recruitment into the breeding pool from the Bd-positive subadult class is significantly reduced. These impacts may be exacerbated by the present and growing threat of climate change, although this effect may take years to materialize.

In summary, based on the best available scientific and commercial information, we consider other natural and manmade factors to be substantial ongoing threats to the Sierra Nevada yellow-legged frog and the northern DPS of the mountain yellow-legged frog. These include high, prevalent risk associated with climate change and small population sizes, and the associated risk from the additive or synergistic effects of these two stressors interacting with other acknowledged threats, including habitat fragmentation and degradation (see Factor A), disease and predation (see Factor C), or other threats currently present but with low relative contribution in isolation.

### **Determination for the Sierra Nevada Yellow-legged Frog**

We have carefully assessed the best scientific and commercial information available regarding the past, present, and future threats to the Sierra Nevada yellow-legged frog. The best available information for the Sierra Nevada yellow-legged frog shows that the geographic extent of the species' range has declined, with local population-level changes first noticed in the early 1900s (Grinnell and Storer 1924, p. 664) although they were still abundant at many sites in the Sierra Nevada until the 1960s (Zweifel 1955, pp. 237–238). Population losses continued between the 1960s and 1990s (Bradford *et al.* 1993, p. 883) and have continued in recent decades. Now fewer, increasingly isolated populations maintain viable recruitment (entry of post-metamorphic frogs into the breeding population). Coupled with the observation that remnant populations are also numerically smaller (in some cases consisting of few individuals), this reduction in occupancy and population density across the landscape suggests significant losses in metapopulation viability and high attendant risk to the overall population of the species. The impacts of the declines on population resilience are two-fold: (1) The geographic extent and number of populations are reduced across the landscape, resulting in fewer and more isolated populations (the species is less able to withstand population stressors and unfavorable conditions exist for genetic exchange or dispersal to unoccupied areas (habitat fragmentation)); and (2) species abundance (in any given population) is reduced, making local extirpations much more likely (decreased population viability). Knapp *et al.* (2007b, pp. 1–2) estimated a 10 percent decline per year in the number of remaining mountain yellow-legged frog populations and argued for the listing of the species as endangered based on this observed rate of population loss.



Threats that face the Sierra Nevada mountain yellow-legged frog, discussed above under Factors A, C, D, and E, increase the risk of the species' extinction, given the isolation of remaining populations. The best available science indicates that the introduction of fishes to the frog's habitat to support recreational angling is one of the primary causes of the decline of the Sierra Nevada yellow-legged frog and poses a current and continuing threat to the species (Factor A). Water bodies throughout this range have been intensively stocked with introduced fish (principally trout). It is a threat of significant influence, and although fewer lakes are stocked currently than were stocked prior to 2001, it remains prevalent today because fish persist in many high-elevation habitats even where stocking has ceased. Further, the introduction of fish has generally restricted remaining Sierra Nevada yellow-legged frog populations to more marginal habitats, thereby increasing the likelihood of localized extinctions. Recolonization in these situations is difficult for a highly aquatic species with high site fidelity and unfavorable dispersal conditions.

Historical livestock grazing activities may also have modified the habitat of the Sierra Nevada yellow-legged frog throughout much of its range (Factor A). Grazing pressure has been significantly reduced from historical levels, but is expected to have legacy effects on mountain yellow-legged frog habitat where prior downcutting and headcutting of streams have resulted in reduced water tables and would benefit from restoration. Current grazing that complies with forest standards and guidelines is not expected to cause habitat-related effects to the species in almost all cases, but in limited cases may continue to contribute to some localized degradation and loss of suitable

habitat. The habitat-related effects of recreation, packstock grazing, dams and water diversions, roads, timber harvests, and fire management activities on the Sierra Nevada yellow-legged frog (Factor A) may have contributed to historical losses when protections and use limits that are currently afforded by USFS and NPS standards and guidelines did not exist. Currently, Federal land management agencies with jurisdiction within the current range of the Sierra Nevada yellow-legged frog have developed management standards and guidelines that limit habitat damage due to these activities, although in localized areas habitat-related changes may continue to affect individual populations.

Competitive exclusion and predation by fish have eliminated or reduced mountain yellow-legged frog populations in stocked habitats, and left remnant populations isolated, while bullfrogs are expected to have negative effects where they occur (Factor C). It is important to recognize that, throughout the vast majority of its range, Sierra Nevada yellow-legged frogs did not co-evolve with any species of fish, as they predominantly occur in water bodies above natural fish barriers. Consequently, the species has not evolved defenses against fish predation.

Sierra Nevada yellow-legged frogs are vulnerable to multiple pathogens (see Factor C) whose effects range from low levels of infection within persistent populations to disease-induced extirpation of entire populations. The Bd epidemic has caused extirpations of Sierra Nevada yellow-legged frog populations throughout its range and caused associated significant declines in numbers of individuals. Though Bd was only recently discovered to affect the Sierra Nevada yellow-legged frog, it appears to infect

populations at much higher rates than other pathogens. The imminence of this risk to populations in currently uninfected habitats is immediate and the potential effects severe. The already-realized effects to the survival of sensitive amphibian life stages in Bd-positive areas are well-documented. Although some populations survive the initial Bd wave, survival rates of metamorphs and population viability are markedly reduced relative to historical (pre-Bd) norms.

These threats described above are likely to be exacerbated by widespread changes associated with climate change and by current small population sizes in many locations (see Factor E), while instances of direct and indirect mortality are expected to have population-level effects only in relatively uncommon, localized situations. On a rangewide basis, the existing regulatory mechanisms (Factor D) have not been effective in protecting populations from declines due to fish stocking and continuing presence of fish and to disease, although standards and guidelines developed by the USFS and the NPS have largely limited threats due to livestock and packstock grazing, recreation, and timber use.

The main and interactive effects of these various risk factors have acted to reduce Sierra Nevada yellow-legged frog populations to small fractions of their historical habitat and reduce population abundances significantly throughout most of its current range. Remaining areas that have yet to be impacted by Bd are at immediate and severe risk.

Given the life history of this species, dispersal, recolonization, and genetic exchange are largely precluded by the fragmentation of habitat common throughout its current range as a result of fish introductions. Frogs that may disperse are susceptible to hostile conditions in many circumstances. In essence, Sierra Nevada yellow-legged frogs have been marginalized by historical fish introductions. Populations have recently been decimated by Bd, and the cumulative effect of other stressors (such as anticipated reduction of required aquatic breeding habitats with climate change and more extreme weather) upon a fragmented landscape make adaptation and recovery a highly improbable scenario without active intervention. The cumulative risk from these stressors to the persistence of the Sierra Nevada yellow-legged frog throughout its range is significant.

The Act defines an endangered species as any species that is “in danger of extinction throughout all or a significant portion of its range” and a threatened species as any species “that is likely to become endangered throughout all or a significant portion of its range within the foreseeable future.” We find that the Sierra Nevada yellow-legged frog is presently in danger of extinction throughout its entire range, based on the immediacy, severity, and scope of the threats described above. Specifically, these include habitat degradation and fragmentation under Factor A, predation and disease under Factor C, and climate change and the interaction of these various stressors cumulatively impacting small remnant populations under Factor E. There has been a rangewide reduction in abundance and geographic extent of surviving populations of the Sierra Nevada yellow-legged frog following decades of fish stocking, habitat

fragmentation, and, most recently, a disease epidemic. Surviving populations are smaller and more isolated, and recruitment in Bd-positive populations is much reduced relative to historical norms. This combination of population stressors makes species persistence precarious throughout the current range in the Sierra Nevada.

We have carefully assessed the best scientific and commercial information available regarding the past, present, and future threats to the species, and have determined that the Sierra Nevada yellow-legged frog meets the definition of endangered under the Act, rather than threatened. This is because significant threats are occurring now and will occur in the future, at a high magnitude and across the species' entire range, making the species in danger of extinction at the present time. The rate of population decline remains high in the wake of Bd epidemics, and the remaining Sierra Nevada yellow-legged frog populations are at high, imminent risk. Population declines are expected to continue as maturing tadpoles succumb to Bd infection, and fragmented populations at very low abundances will face significant obstacles to recovery. Therefore, on the basis of the best available scientific and commercial information, and the threats posed to these species under the listing factors above, we are listing the Sierra Nevada yellow-legged frog as endangered in accordance with sections 3(6) and 4(a)(1) of the Act.

Under the Act and our implementing regulations, a species may warrant listing if it is endangered or threatened throughout all or a significant portion of its range. The Sierra Nevada yellow-legged frog is restricted in its range, and the threats occur

throughout the remaining occupied habitat. Therefore, we assessed the status of this species throughout its entire range. The threats to the survival of the species occur throughout the species' range and are not restricted to any particular significant portion of that range. Accordingly, our assessment and final determination applies to the species throughout its entire range.

### **Final Determination for the Northern DPS of the Mountain Yellow-legged Frog**

We have carefully assessed the best scientific and commercial information available regarding the past, present, and future threats to the northern DPS of the mountain yellow-legged frog. The best available information for the northern DPS of the mountain yellow-legged frog shows that the geographic extent of the species' range has declined, with local population-level changes first noticed in the early 1900s (Grinnell and Storer 1924, p. 664), although they were still abundant at many sites in the Sierra Nevada until the 1960s (Zweifel 1955, pp. 237–238). Population losses continued between the 1960s and 1990s (Bradford *et al.* 1993, p. 883) and have continued in recent decades. Now fewer, increasingly isolated populations maintain viable recruitment (entry of post-metamorphic frogs into the breeding population). Coupled with the observation that remnant populations are also numerically smaller (in some cases consisting of a few individuals), this reduction in occupancy and population density across the landscape suggests significant losses in metapopulation viability and high attendant risk to the overall population of the species. The impacts of the declines on population resilience are two-fold: (1) The geographic extent and number of populations are reduced across

the landscape, resulting in fewer and more isolated populations (the species is less able to withstand population stressors and unfavorable conditions exist for genetic exchange or dispersal to unoccupied areas (habitat fragmentation)); and (2) species abundance (in any given population) is reduced, making local extirpations much more likely (decreased population viability). Knapp *et al.* (2007b, pp. 1–2) estimated a 10 percent decline per year in the number of remaining mountain yellow-legged frog populations and argued for the listing of the species as endangered based on this observed rate of population loss.

Threats that face the northern DPS of the mountain yellow-legged frog, discussed above under Factors A, C, D, and E, increase the risk of the species' extinction, given the isolation of remaining populations. The best available science indicates that the introduction of fishes to the frog's habitat to support recreational angling is one of the primary causes of the decline of the northern DPS of the mountain yellow-legged frog and poses a current and continuing threat to the species (Factor A). Water bodies throughout this range have been intensively stocked with introduced fish (principally trout). It is a threat of significant influence, and although fewer lakes are stocked currently than were stocked prior to 2001, it remains prevalent today because fish persist in many high-elevation habitats even where stocking has ceased. Recolonization in these situations is difficult for a highly aquatic species with high site fidelity and unfavorable dispersal conditions. Climate change is likely to exacerbate these other threats and further threaten population resilience.

Historical livestock grazing activities may also have modified the habitat of the northern DPS of the mountain yellow-legged frog throughout much of its range (Factor A). Grazing pressure has been significantly reduced from historical levels, but is expected to have legacy effects to mountain yellow-legged frog habitat where prior downcutting and headcutting of streams have resulted in reduced water tables that still need restoration to correct. Current grazing that complies with forest standards and guidelines is not expected to cause habitat-related effects to the species in almost all cases, but in limited cases may continue to contribute to some localized degradation and loss of suitable habitat. The habitat-related effects of recreation, packstock grazing, dams and water diversions, roads, timber harvests, and fire management activities on the northern DPS of the mountain yellow-legged frog (Factor A) may have contributed to historical losses when protections and use limits that are currently afforded by USFS and NPS standards and guidelines did not exist. Currently, Federal agencies with jurisdiction within the current range of the northern DPS of the mountain yellow-legged frog have developed management standards and guidelines that limit habitat damage due to these activities, although in localized areas habitat-related changes may continue to affect individual populations.

Competitive exclusion and predation by fish have eliminated or reduced mountain yellow-legged frog populations in stocked habitats, and left remnant populations isolated, while bullfrogs are expected to have negative effects where they occur (Factor C). It is important to recognize that throughout the vast majority of its range, the northern DPS of the mountain yellow-legged frogs did not co-evolve with any species of fish, as this



species predominantly occurs in water bodies above natural fish barriers. Consequently, the species has not evolved defenses against fish predation.

Mountain yellow-legged frogs are vulnerable to multiple pathogens (see Factor C) whose effects range from low levels of infection within persistent populations to disease-induced extirpation of entire populations. The Bd epidemic has caused rangewide extirpations of populations of the northern DPS of the mountain yellow-legged frog and associated significant declines in numbers of individuals. Though Bd was only recently discovered to affect the mountain yellow-legged frog, it appears to infect populations at much higher rates than other pathogens. The imminence of this risk to currently uninfected habitats is immediate, and the potential effects severe. The already-realized effects to the survival of sensitive amphibian life stages in Bd-positive areas are well-documented. Although some populations survive the initial Bd wave, survival rates of metamorphs and population viability are markedly reduced relative to historical (pre-Bd) norms.

These threats are likely to be exacerbated by widespread changes associated with climate change and by current small population sizes in many locations (see Factor E), while instances of direct and indirect mortality are expected to have population-level effects only in relatively uncommon, localized situations. Rangewide, the existing regulatory mechanisms (Factor D) have not been effective in protecting populations from declines due to fish stocking and continuing presence of fish and to disease, although

standards and guidelines developed by the USFS and the NPS have largely limited threats due to livestock and packstock grazing, recreation, and timber use.

The main and interactive effects of these various risk factors have acted to reduce the northern DPS of the mountain yellow-legged frog to a small fraction of its historical range and reduce population abundances significantly throughout most of its current range. Populations of this species in remaining areas in the southern Sierra Nevada that have yet to be impacted by Bd are at immediate and severe risk.

Given the life history of this species, dispersal, recolonization, and genetic exchange are largely precluded by the fragmentation of habitat common throughout its current range as a result of fish introductions. Frogs that may disperse are susceptible to hostile conditions in many circumstances. In essence, mountain yellow-legged frogs have been marginalized by historical fish introductions. Populations have recently been decimated by Bd, and the accumulation of other stressors (such as anticipated reduction of required aquatic breeding habitats with climate change and more extreme weather) upon a fragmented landscape make adaptation and recovery a highly improbable scenario without active intervention. The cumulative risk from these stressors to the persistence of the mountain yellow-legged frog throughout its range is significant.

The Act defines an endangered species as any species that is “in danger of extinction throughout all or a significant portion of its range” and a threatened species as any species “that is likely to become endangered throughout all or a significant portion of

its range within the foreseeable future.” We find that the northern DPS of the mountain yellow-legged frog is presently in danger of extinction throughout its entire range, based on the immediacy, severity, and scope of the threats described above. Specifically, these include habitat degradation and fragmentation under Factor A, predation and disease under Factor C, and climate change and the interaction of these various stressors cumulatively impacting small remnant populations under Factor E. There has been a rangewide reduction in abundance and geographic extent of surviving populations of the northern DPS of the mountain yellow-legged frog following decades of fish stocking, habitat fragmentation, and, most recently, a disease epidemic. Surviving populations are smaller and more isolated, and recruitment in Bd-positive populations is much reduced relative to historical norms. This combination of population stressors makes species persistence precarious throughout the current range in the Sierra Nevada.

We have carefully assessed the best scientific and commercial information available regarding the past, present, and future threats to the species, and have determined that the northern DPS of the mountain yellow-legged frog, meets the definition of endangered under the Act, rather than threatened. This is because significant threats are occurring now and will occur in the future, at a high magnitude and across the DPS’ entire range, making the northern DPS of the mountain yellow-legged frog in danger of extinction at the present time. The rate of population decline remains high in the wake of Bd epidemics, and northern DPS of the mountain yellow-legged frog areas are at high, imminent risk. The recent rates of decline for these populations are even higher than declines in the populations of the Sierra Nevada yellow-legged frog, and

as Bd infects remaining core areas, population viability will be significantly reduced, and extirpations or significant population declines are expected. Population declines are expected to continue as maturing tadpoles succumb to Bd infection, and fragmented populations at very low abundances will face significant obstacles to recovery. Therefore, on the basis of the best available scientific and commercial information, and the threats posed to these species discussed under the listing factors above, we are listing the northern DPS of the mountain yellow-legged frog as endangered in accordance with sections 3(6) and 4(a)(1) of the Act.

Under the Act and our implementing regulations, a species may warrant listing if it is endangered or threatened throughout all or a significant portion of its range. The northern DPS of the mountain yellow-legged frog addressed in this final listing rule is restricted in its range, and the threats occur throughout the remaining occupied habitat. Therefore, we assessed the status of this DPS throughout its entire range in the Sierra Nevada of California. The threats to the survival of this DPS occur throughout its range in the southern Sierra Nevada and are not restricted to any particular significant portion of that range. Accordingly, our assessment and final determination applies to the DPS throughout its entire range.

## **Summary of Biological Status and Threats Affecting the Yosemite Toad**

### **Background**

## Taxonomy and Species Description

Please refer to the proposed listing rule for the Yosemite toad under the Act (16 U.S.C. 1531 *et seq.*) for additional species information, including detailed information on taxonomy. In this section of the final rule, it is our intent to discuss only those topics directly relevant to the listing of the Yosemite toad (*Anaxyrus canorus*) as threatened.

## Habitat and Life History

Breeding habitat—Yosemite toads are associated with wet meadows due to their breeding ecology. Camp (1916, pp. 59–62) found Yosemite toads in wet meadow habitats and at lake shores located among lodgepole (*Pinus contorta*) at the lower elevations to whitebark (*P. albicaulis*) pines at the higher elevations. Mullally (1953, pp. 182–183) found adult toads common on the margins of high-elevation lakes, streams, and pools wherever the meadow vegetation was thicker or more luxuriant than usual or where there were patches of low willows (*Salix* spp.). Liang (2010, p. 81) observed Yosemite toads most frequently associated with (in order of preference): wet meadows, alpine-dwarf scrub, red fir (*Abies magnifica*), water, lodgepole pine, and subalpine conifer habitats.

Yosemite toads were found as often at large as at small sites (Liang 2010, p. 19), suggesting that this species is capable of successfully utilizing small habitat patches. Liang also found that population persistence was greater at higher elevations, with an

affinity for relatively flat sites with a southwesterly aspect (Liang 2010, p. 20; see also Mullally 1953, p. 182). These areas receive higher solar radiation and are capable of sustaining hydric (wet), seasonally ponded, and mesic (moist) breeding and rearing habitat. The Yosemite toad is more common in areas with less variation in mean annual temperature, or more temperate sites with less climate variation (Liang 2010, pp. 21–22).

Adults are thought to be long-lived, and this factor allows for persistence in variable conditions and more marginal habitats where only periodic good years allow high reproductive success (USFS *et al.* 2009, p. 27). Females have been documented to reach 15 years of age, and males as many as 12 years (Kagarise Sherman and Morton 1993, p. 195); however, the average longevity of the Yosemite toad in the wild is not known. Jennings and Hayes (1994, p. 52) indicated that females begin breeding at ages 4 to 6 years, while males begin breeding at ages 3 to 5 years.

Adults appear to have high site-fidelity; Liang (2010, pp. 99, 100) found that the majority of individuals identified in multiple years were located in the same meadow pools, although individuals will move between breeding areas (Liang 2010, p. 52; Liang 2013, p. 561). Breeding habitat includes shallow, warm-water areas in wet meadows, such as shallow ponds and flooded vegetation, ponds, lake edges, and slow-flowing streams (Karlstrom 1962, pp. 8–12; Brown 2013, unpaginated). Tadpoles have also been observed in shallow areas of lakes (Mullally 1953, pp. 182–183).

Adult Yosemite toads are most often observed near water, but only occasionally in water (Mullally and Cunningham 1956b, pp. 57–67). Moist upland areas such as seeps and springheads are important summer nonbreeding habitats for adult toads (Martin 2002, pp. 1–3). The majority of their life is spent in the upland habitats proximate to their breeding meadows. They use rodent burrows for overwintering and probably for temporary refuge during the summer (Jennings and Hayes 1994, pp. 50–53), and they spend most of their time in burrows (Liang 2010, p. 95). They also use spaces under surface objects, including logs and rocks, for temporary refuge (Stebbins 1951, pp. 245–248; Karlstrom 1962, pp. 9–10). Males and females also likely inhabit different areas and habitats when not breeding, and females tend to move farther from breeding ponds than males (USFS *et al.* 2009, p. 28).

Males exit burrows first, and spend more time in breeding pools than females, who do not breed every year (Kagarise Sherman and Morton, 1993, p. 196). Data suggest that higher lipid storage in females, which enhances overwinter survival, also precludes the energetic expense of breeding every year (Morton 1981, p. 237). The Yosemite toad is a prolific breeder, laying many eggs immediately at snowmelt. This is accomplished in a short period of time, coinciding with water levels in meadow habitats and ephemeral pools they use for breeding. Female toads lay approximately 700–2,000 eggs in two strings (one from each ovary) (USFS *et al.* 2009, p. 21). Females may split their egg clutches within the same pool, or even between different pools, and may lay eggs communally with other toads (USFS *et al.* 2009, p. 22).

Eggs hatch within 3–15 days, depending on ambient water temperatures (Kagarise Sherman 1980, pp. 46–47; Jennings and Hayes 1994, p. 52). Tadpoles typically metamorphose around 40–50 days after fertilization, and are not known to overwinter (Jennings and Hayes 1994, p. 52). Tadpoles are black in color, tend to congregate together (Brattstrom 1962, pp. 38–46) in warm shallow waters during the day (Cunningham 1963, pp. 60–61), and then retreat to deeper waters at night (Mullaly 1953, p. 182). Rearing through metamorphosis takes approximately 5–7 weeks after eggs are laid (USFS *et al.* 2009, p. 25). Toads need shallow, warm surface water that persists through the period during which they metamorphose; shorter hydroperiods in that habitat can reduce reproductive success (Brown 2013, unpaginated).

Reproductive success is dependent on the persistence of tadpole rearing sites and conditions for breeding, egg deposition, hatching, and rearing to metamorphosis (USFS *et al.* 2009, p. 23). Given their association with shallow, ephemeral habitats, Yosemite toads are susceptible to droughts and weather extremes. Abiotic factors leading to mortality (such as freezing or desiccation) appear to be more significant during the early life stages of toads, while biotic factors (such as predation) are probably more prominent factors during later life stages (USFS *et al.* 2009, p. 30). However, since adult toads lead a much more inconspicuous lifestyle, direct observation of adult mortality is difficult and it is usually not possible to determine causes of adult mortality.

Yosemite toads can move farther than 1 km (0.63 mi) from their breeding meadows (average movement is 275 m (902 ft)), and they utilize terrestrial environments



extensively (Liang 2010, p. 85). The average distance traveled by females is twice as far as males, and home ranges for females are 1.5 times greater than those for males (Liang 2010, p. 94). Movement into the upland terrestrial environment following breeding does not follow a predictable path, and toads tend to traverse longer distances at night, perhaps to minimize evaporative water loss (Liang 2010, p. 98). Martin (2008, p. 123) tracked adult toads during the active season and found that on average toads traveled a total linear distance of 494 m (1,620 ft) within the season, with minimum travel distance of 78 m (256 ft) and maximum of 1.76 km (1.09 mi).

#### Historical Range and Distribution

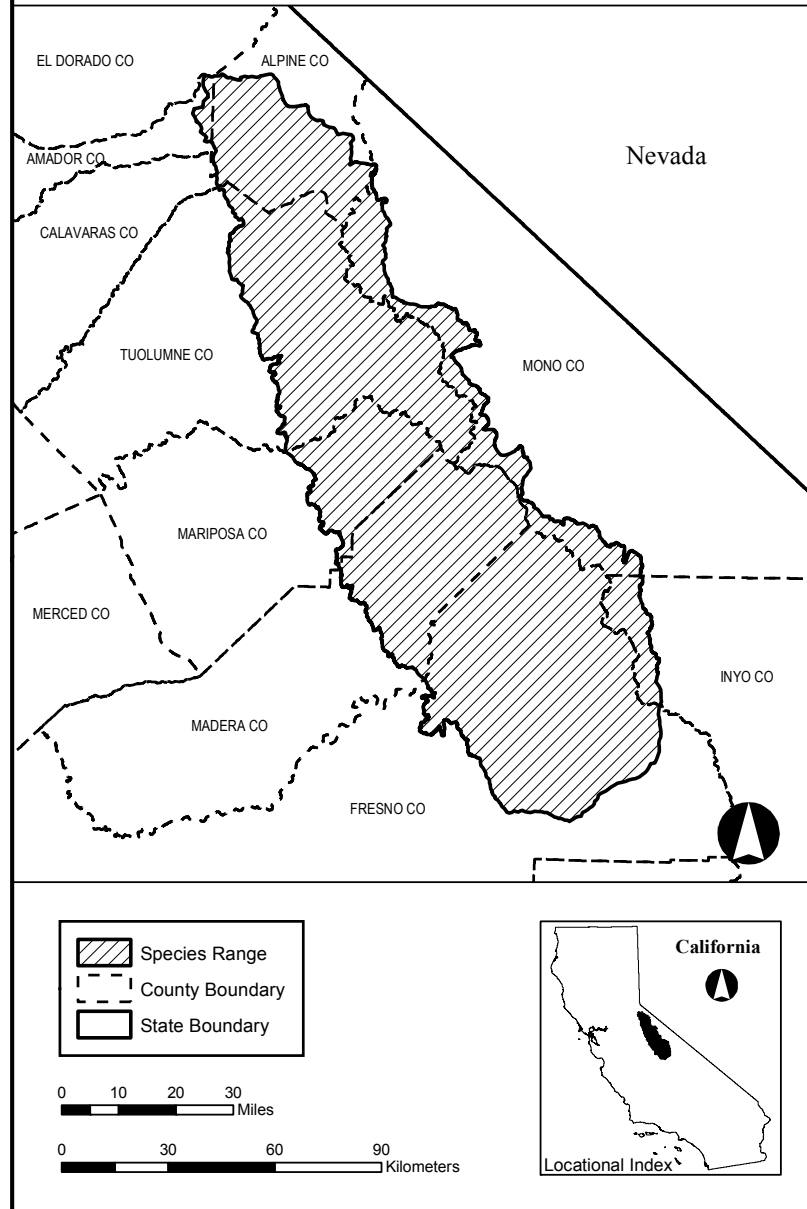
The known historical range of the Yosemite toad in the Sierra Nevada extended from the Blue Lakes region north of Ebbetts Pass (Alpine County) to south of the Evolution Lake area (Fresno County) (Karlstrom 1962, p. 3; Stebbins 1985, p. 72; see also Knapp 2013, unpaginated; Brown 2013, unpaginated). Yosemite toad habitat historically spanned elevations from 1,460 to 3,630 m (4,790 to 11,910 ft) (Stebbins 1985, p. 72; Stephens 2001, p. 12).

#### Current Range and Distribution

The current range of the Yosemite toad, at least in terms of overall geographic extent, remains largely similar to the historical range defined above (USFS *et al.* 2009, p. 41). However, within that range, toad habitats have been degraded and may be

decreasing in area as a result of conifer encroachment and historical livestock grazing (see Factor A below). The vast majority of the Yosemite toad's range is within federally managed land. Figure 2, Estimated Range of Yosemite Toad, displays a range map for the species.

**Figure 2**  
**Estimated Range of Yosemite Toad**



## Population Estimates and Status

Baseline data on the number and size of historical Yosemite toad populations are limited, and historic records are largely based on accounts from field notes, or pieced together through museum collections, thereby providing limited information on historical populations. Systematic survey information across the range of the species on National Forest System Lands largely follows the designation of the Yosemite toad as a candidate species under the Act. In addition, surveys for the Yosemite toad have been conducted within Yosemite, Kings Canyon, and Sequoia National Parks (Knapp 2013, unpaginated). From these recent inventories, Yosemite toads have been found at 469 localities collectively on six National Forests (USFS *et al.* 2009, p. 40; see also Brown and Olsen 2013, pp. 675–691), at 179 breeding sites that were surveyed between 1992 and 2010 in Yosemite National Park (Berlow *et al.* 2013, p. 3), and detected at 18 localities in Kings Canyon National Park (NPS 2011, geospatial data). Although we did not cite to the information from the National Parks in the proposed rule, we had the geospatial occupancy data that is currently included in Berlow *et al.* 2013, and we utilized that data in our analysis for the proposed listing (see comments 6 and 7 below, and their respective responses). The number of localities identified in these surveys reflects more occupied sites than were known before such extensive surveys were conducted, and indicates that the species is still widespread throughout its range. These inventories were typically conducted to determine toad presence or absence (they were not censuses), and do not explicitly compare historic sites to recent surveys. Moreover, single-visit surveys of toads are unreliable as indices of abundance because timing is so critical to the presence

of detectable life stages and not all potential breeding habitats within the range of the species were surveyed (USFS *et al.* 2009, p. 41; Liang 2010, p. 10; Brown and Olsen 2013, p. 685). Given these considerations, conclusions about population trends, abundance, or extirpation rates are not possible from these datasets overall.

One pair of studies allows us to compare current distribution with historic distributions and indicates that large reductions have occurred. In 1915 and 1919, Grinnell and Storer (1924, pp. 657–660) surveyed for vertebrates at 40 sites along a 143-km (89-mi) west-to-east transect across the Sierra Nevada, through Yosemite National Park, and found Yosemite toads at 13 of those sites. In 1992, Drost and Fellers (1996, pp. 414–425) conducted more thorough surveys, specifically for amphibians, at 38 of the Grinnell and Storer sites plus additional nearby sites. Drost and Fellers (1996, pp. 418) found that Yosemite toads were absent from 6 of 13 sites where they had been found in the original Grinnell and Storer (1924) survey. Moreover, at the sites where they were present, Yosemite toads most often occurred in very low numbers relative to general abundance reported in the historical record (Grinnell and Storer 1924, pp. 657–660). Therefore, by the early 1990s, the species was either undetectable or had declined in numbers at 9 of 13 (69 percent) of the Grinnell and Storer sites (Drost and Fellers 1996, p. 418).

Another study comparing historic and current occurrences also found a large decline in Yosemite toad distribution. In 1990, David Martin surveyed 75 sites throughout the range of the Yosemite toad for which there were historical records of the

species' presence. This study found that 47 percent of historically occupied sites showed no evidence of any life stage of the species (Stebbins and Cohen 1995, pp. 213–215). This result suggests a range-wide decline to about one half of historical sites, based on occupancy alone.

A third study comparing historic and recent surveys indicates declines in Yosemite toad distribution. Jennings and Hayes (1994, pp. 50–53) reviewed the current status of Yosemite toads using museum records of historic and recent sightings, published data, and unpublished data and field notes from biologists working with the species. They estimated a loss of over 50 percent of former Yosemite toad locations throughout the range of the species (based on 144 specific sites).

The only long-term, site-specific population study for Yosemite toads documented a dramatic decline over 2 decades of monitoring. Kagarise Sherman and Morton (1993, pp. 186–198) studied Yosemite toads at Tioga Pass Meadow (Mono County, California) from 1971 through 1991 (with the most intensive monitoring through 1982). They documented a decline in the average number of males entering the breeding pools from 258 to 28 during the mid-1970s through 1982. During the same time period, the number of females varied between 45 and 100, but there was no apparent trend in number observed. During the 1980s, it appeared that males continued to decline, females also declined, and breeding activity became sporadic. By 1991, they found only one male and two egg masses. Sadinski (2004, p. 40) revisited the survey locations annually from 1995 and 2001 and found a maximum of two males and two egg masses, suggesting

the toads in Tioga Meadows had not recovered from their decline. In the study of Yosemite toads at nearby Dana Meadows, Sadinski (2004, pp. 39–42) documented few adults within the habitats surveyed, finding substantial mortality in embryos that he associated with effects of ice, water mold, and flatworms. Sadinski (2004, pp. 38–42) also found high larval mortality when breeding sites dried before larvae could reach metamorphosis. Sadinski (2004) stated that the proximity of the Kagarise Sherman and Morton (1993) study sites at Tioga Meadows and his sites in Dana Meadows practically ensured that animals from both sites were part of the same metapopulation. Sadinski surmised that perhaps much of that metapopulation experienced events at breeding sites similar to those that Kagarise Sherman and Morton (1993) observed (Sadinski 2004, pp. 39–40). He further opined that, if each of his substantial sites had previously supported hundreds of breeding adults in the 1970s, the overall population of Yosemite toads had declined dramatically throughout the area since that time.

Kagarise Sherman and Morton (1993, pp. 186–198) also conducted occasional surveys of six other populations in the eastern Sierra Nevada. Five of these populations showed long-term declines that were evident beginning between 1978 through 1981, while the sixth population held relatively steady until the final survey in 1990, at which time it dropped. In 1991, E.L. Karlstrom revisited the site where he had studied a breeding population of Yosemite toads from 1954 to 1958 (just south of Tioga Pass Meadow within Yosemite National Park), and found no evidence of toads or signs of breeding (Kagarise Sherman and Morton 1993, p. 190).

The most reliable information about Yosemite toad population status and trends is the USFS SNAMPH. This study, conducted on National Forest System Lands, is designed to provide statistical comparisons across 5-year monitoring cycles with 134 watersheds (Brown *et al.* 2011, pp. 3–4). This approach allows researchers to assess trends for the entire range of the toad, rather than at limited survey sites (C. Brown 2012, pers. comm., see also Brown and Olsen 2013). The results of this assessment indicate the species has declined from historical levels, with Yosemite toads occurring in approximately 13 percent of watersheds where they existed prior to 1990. This study also found that breeding was occurring in approximately 84 percent of the watersheds that were occupied in the period 1990–2001, suggesting that the number of locations where breeding occurs has continued to decline. Additionally, the study found that breeding currently occurs in an estimated 22 percent of watersheds within the current estimated range of the species (Brown *et al.* 2012, p. 115).

Moreover, overall abundances in the intensively monitored watersheds were very low (fewer than 20 males per meadow per year) relative to other historically reported abundances of the species (Brown *et al.* 2011, p. 4). Brown *et al.* (2011, p. 35) suggest that populations are now very small across the range of the species. During their monitoring over the past decade, they found only 18 percent of occupied survey watersheds range-wide had “large” populations (more than 1,000 tadpoles or 100 of any other lifestage detected at the time of survey). While not all surveys were conducted at the peak of tadpole presence and adults are not reliably found outside of the breeding season, Brown *et al.* (2012) surveyed many sites at appropriate times and rarely found the



large numbers of tadpoles or metamorphs that would be expected if population sizes were similar to those reported historically. The researchers interpret these data, in combination with documented local population declines from other studies (see above), to support the hypothesis that population declines have occurred range-wide (Brown *et al.* 2012, p. 11).

### **Summary of Changes from the Proposed Rule for the Yosemite Toad**

Based on peer review and Federal, State, and public comments (see comments in the **Summary of Comments and Recommendations** section, below), we clarified information for the Yosemite toad to better characterize our knowledge of the species' habitat requirements. Specifically, we reorganized and clarified the habitat details (Habitat and Life History), southern extent of the species' range (Historic Range and Distribution), and species surveys (USFS and NPS). We also added information on occupancy in National Parks that was inadvertently omitted from the proposed rule (Population Estimates and Status).

In the **Summary of Factors Affecting the Species** section, under Factor A, we made small changes to the discussion about meadow loss and degradation in order to improve clarity. In the Livestock Use (Grazing) Effects to Meadow Habitat section, we reorganized the information and separated the effects of historic livestock grazing from the effects due to current grazing levels, and we added additional references received from the USFS. In the Roads and Timber Harvest Effects to Meadow Habitat section, we clarified the extent to which these activities overlap with the Yosemite toad's range and

distinguished the effects of past activities from the effects of current activities. We added information on road locations and on USFS Forest standards and guidelines that currently limit the effects of these activities on riparian areas. In this final rule, we found that roads and timber harvest activities are not current and ongoing threats to the species. However, there may be localized effects where legacy effects of past road building or timber harvest continue to modify wet meadows or where activities occur in close proximity to extant Yosemite toad populations.

In the Fire Management section, we added information to clarify that Yosemite toads primarily occur in higher elevation areas where fire suppression activities are rarely conducted. This finding suggests that fire suppression has had little effect on forest encroachment into meadow habitats in most areas where the species occurs. In the Recreation and Packstock Effects to Meadow Habitat section, we added additional information on USFS and NPS restoration activities to protect meadows, off-highway vehicle effects, packstock use, and agency monitoring and protection activities to limit effects due to packstock use. We revised our conclusion to clarify that, in general, we do not consider habitat-related changes associated with current levels of hiking, backpacking, or packstock use to pose a risk to Yosemite toad populations. Recreation may have habitat-related effects to toads in localized areas where use adjacent to occupied meadows is exceptionally heavy, or where heavy or motorized use results in changes to meadow hydrology. Accordingly, rangewide, recreation is a threat of low prevalence. In the section on Dams and Water Diversions, we added information to clarify that almost all reservoirs are located below the range of the Yosemite toad. We

include small changes in the Climate Change section to improve clarity or add information from references provided during peer review.

In Factor B, we added information provided during the comment period, which documented the sale of one Yosemite toad from a pet store in Southern California (store now closed). We also added information on protections provided by agency-required research permits. In Factor C, based on peer review comments, we added information on a Bd study on Yosemite toads. We removed the discussion of contaminants under Factor E, and we refer readers to the proposed rule affirming that the best available information indicates that contaminants do not pose a current or continuing threat to the Yosemite toad. We also added new information in the Other Sources of Direct and Indirect Mortality section as a result of information provided during peer review. Although we have not changed the determination, we have made a few small changes in the wording of the determination for the Yosemite toad to reflect the above changes.

### **Summary of Factors Affecting the Species**

Section 4 of the Act (16 U.S.C. 1533), and its implementing regulations at 50 CFR part 424, set forth the procedures for adding species to the Federal Lists of Endangered and Threatened Wildlife and Plants. Under section 4(a)(1) of the Act, we may list a species based on any of the following five factors: (A) The present or threatened destruction, modification, or curtailment of its habitat or range; (B) overutilization for commercial, recreational, scientific, or educational purposes; (C)

disease or predation; (D) the inadequacy of existing regulatory mechanisms; and (E) other natural or manmade factors affecting its continued existence. Listing actions may be warranted based on any of the above threat factors, singly or in combination. Each of these factors is discussed below, and changes from the proposed rule (78 FR 24472, April 25, 2013) are reflected in these discussions.

*Factor A. The Present or Threatened Destruction, Modification, or Curtailment of Its Habitat or Range*

The habitat comprising the current range of the Yosemite toad is generally characterized by low levels of physical disturbance (there is little to no current development pressure). However, these areas are also generally more sensitive to perturbation and take longer to recover from disturbances due to reduced growing seasons and harsher environmental conditions. Since Yosemite toads rely heavily on shallow, ephemeral water, they may be more sensitive to minor changes in their habitat. Loss or alteration of suitable breeding habitat can reduce reproductive success, which may have a profound impact when population numbers are small. Past management and development activity has played a role in the degradation of meadow habitats within the Sierra Nevada. Human activities within these habitats include grazing, timber harvest, fuels management, recreation, and water development.

**Meadow Habitat Loss and Degradation**

Some of the habitat effects associated with grazing activities that were described for the mountain yellow-legged frogs (see the **Summary of Factors Affecting the Species** section for those species, above) also apply to Yosemite toads. However, there are differences based on the Yosemite toad's reliance on very shallow, ephemeral water in meadow and pool habitats versus the deeper lakes and streams frequented by mountain yellow-legged frogs. Because Yosemite toads rely on very shallow, ephemeral water, they may be sensitive to even minor changes in their habitat, particularly to hydrology (Brown 2013, unpaginated). Meadow habitat quality in the Western United States, and specifically the Sierra Nevada, has been degraded by past activities, such as overgrazing, tree encroachment, fire suppression, and road building, over the last century (Stillwater Sciences 2008, pp. 1–53; Halpern *et al.* 2010, pp. 717–732; Vale 1987, pp. 1–18; Ratliff 1985, pp. *i*–48). These past activities have contributed to erosion and stream incision in areas of the Sierra Nevada, leading to meadow dewatering and encroachment by invasive vegetation (Menke *et al.* 1996, pp. 25–28; Lindquist and Wilcox 2000, p. 2).

Given the reliance of the Yosemite toad on these meadow and pool habitats for breeding, rearing, and adult survival, it is logical to conclude that the various stressors have had an indirect effect on the viability of Yosemite toad populations via degradation of their habitat. Loss of connectivity of habitats leads to further isolation and population fragmentation. Because of physiological constraints, the tendency to move only short distances, and high site fidelity, amphibians may be unable to recolonize unoccupied sites following local extinctions if the distance between sites is too great, although recolonization can occur over time (Blaustein *et al.* 1994a, p. 8).

Since the existence of meadows is largely dependent on their hydrologic setting, most meadow degradation is due fundamentally to hydrologic alterations (Stillwater Sciences 2008, p. 13). There are many drivers of hydrologic alterations in meadow ecosystems. In some locations, historic water development and ongoing water management activities have physically changed the underlying hydrologic system. Diversion and irrigation ditches formed a vast network that altered local and regional stream hydrology, although these manmade systems are generally below the range of the Yosemite toad. Timber harvest and associated road construction further altered erosion and sediment delivery patterns in rivers and meadow streams. Fire suppression and an increase in the frequency of large wildfires due to excessive fuel buildup have introduced additional disturbance pressures to the meadows of the Sierra Nevada (Stillwater Sciences 2008, p. 13). Many meadows now have downcut stream courses, compacted soils, altered plant community compositions, and diminished wildlife and aquatic habitats (SNEP 1996, pp. 120–121).

Land uses causing channel erosion are a threat to Sierra Nevada meadows. These threats include erosive activities within the watershed upslope of the meadow, along with impacts from land use directly in the meadows themselves. Compaction of meadow soils by roads or intensive trampling (for example, overgrazing) can reduce infiltration, accelerate surface run-off, and thereby lead to channel incision (Menke *et al.* 1996, pp. 25–28). Mining, overgrazing, timber harvesting, and railroad and road construction and maintenance have contributed to watershed degradation, resulting in accelerated erosion,

sedimentation in streams and reservoirs, meadow dewatering, and degraded terrestrial and aquatic habitats (Linguist 2000, p. 2). Deep incision has been documented in several meadows in the Sierra Nevada. One example is Halstead Meadow in Sequoia National Park, where headcutting exceeds 10 feet in many areas and is resulting in widening channels, erosion in additional meadows, and a lowered water table (Cooper and Wolf 2006, p. 1).

The hydrologic effects of stream incision on the groundwater system may significantly impact groundwater storage, affecting late summer soil moisture and facilitating vegetation change (Bergmann 2004, pp. 24–31). For example, in the northern Sierra Nevada, logging, overgrazing, and road/railroad construction have caused stream incision, resulting in dewatering of riparian meadow sediments and a succession from native wet meadow vegetation to sagebrush and dryland grasses (Loheide and Gorelick 2007, p. 2). A woody shrub (*Artemisia rothrockii*) is invading meadows as channel incision causes shallow-water-dependent herbs to die back, allowing shrub seedlings to establish in disturbed areas during wet years (Darrouzet-Nardi *et al.* 2006, p. 31).

Mountain meadows in the western United States and Sierra Nevada have also been progressively colonized by trees (Thompson 2007, p. 3; Vale 1987, p. 6), with an apparent pattern of encroachment during two distinct periods in the late 1800s and mid-1900s (Halpern *et al.* 2010, p. 717). This trend has been attributed to a number of factors, including climate, changes in fire regime, and cessation of sheep grazing (Halpern *et al.* 2010, pp. 717–718; Vale 1987, pp. 10–13), but analyses are limited to correlational

comparisons and research results are mixed, so the fundamental contribution of each potential driver remains uncertain. We discuss the contribution of these factors to habitat loss and degradation for the Yosemite toad below.

#### Livestock Use (Grazing) Effects to Meadow Habitat

The combined effect of legacy conditions from historically excessive grazing use and current livestock grazing activities have the potential to impact habitat in the range of the Yosemite toad. The following subsections discuss the effects of excessive historical grazing, current extent of grazing, and current grazing management practices.

Overgrazing has been associated with accelerated erosion and gulying of meadows (Kattelman and Embury 1996, pp. 13, 18), which leads to siltation and more rapid succession of meadows. Grazing can cause erosion by disturbing the ground, damaging and reducing vegetative cover, and destroying peat layers in meadows, which lowers the groundwater table and summer flows (Armour *et al.* 1994, pp. 9–12; Martin 2002, pp. 1–3; Kauffman and Krueger 1984, pp. 431–434). Downtcut channels, no longer connected to the historic, wide floodplains of the meadow, instead are confined within narrow, incised channels. Downstream, formerly perennial (year-round) streams often become intermittent or dry due to loss of water storage capacity in the meadow aquifers that formerly sustained them (Lindquist *et al.* 1997, pp. 7–8).



Heavy grazing can alter vegetative species composition and contribute to lodgepole pine (*Pinus contorta*) invasion (Ratliff 1985, pp. 33–36). Lowering of the water table facilitates encroachment of conifers into meadows. Gully formation and lowering of water tables, changes in the composition of herbaceous vegetation, increases in the density of forested stands, and the expansion of trees into areas that formerly were treeless have been documented in California wilderness areas and National Parks (Cole and Landres 1996, p. 171). This invasion has been attributed to sheep grazing, though the phenomenon has been observed on both ungrazed meadows and on meadows grazed continually since about 1900 (Ratliff 1985, p. 35), suggesting that other drivers may be involved (see “Effects of Fire Suppression on Meadow Habitats” and “Climate Effects to Meadow Habitat” below).

#### *Effects of Historical Livestock Grazing*

Grazing of livestock in Sierra Nevada meadows and riparian areas (rivers, streams, and adjacent upland areas that directly affect them) began in the mid-1700s with the European settlement of California (Menke *et al.* 1996, p. 7). Following the gold rush of the mid-1800s, grazing increased to a level exceeding the carrying capacity of the available range, causing significant impacts to meadow and riparian ecosystems (Meehan and Platts 1978, p. 275; Menke *et al.* 1996, p. 7). By the turn of the 20<sup>th</sup> century, high Sierra Nevada meadows were converted to summer rangelands for grazing cattle, sheep, horses, goats, and pigs, although the alpine areas were mainly grazed by sheep (Beesley 1996, pp. 7–8; Menke *et al.* 1996, p. 14). Stocking rates of both cattle and sheep in Sierra

meadows in the late 19th and early 20th centuries were very heavy (Kosco and Bartolome 1981, pp. 248–250), and grazing severely degraded many meadows (Ratliff 1985, pp. 26–31; Menke *et al.* 1996, p. 14). Grazing impacts occurred across the entire range of the Yosemite toad, as cattle and sheep were driven virtually everywhere in the Sierra Nevada where forage was available (Kinney 1996, pp. 37–42; Menke *et al.* 1996, p. 14).

Grazing within the National Forests has continued into recent times, with reduction in activity (motivated by resource concerns, conflicts with other uses, and deteriorating range conditions) beginning in the 1920s. A brief wartime increase in the 1940s followed, before grazing continued to be scaled back beginning in the 1950s through the early 1970s. However, despite these reductions, grazing still exceeded sustainable capacity in many areas (Menke *et al.* 1996, p. 9; UC 1996a, p. 115). Historical evidence indicates that heavy livestock use in the Sierra Nevada has resulted in widespread damage to rangelands and riparian systems due to sod destruction in meadows, vegetation destruction, and gully erosion (see review in Brown *et al.* 2009, pp. 56–58 and in USFS *et al.* 2009, p. 57). (For additional information on historical grazing regimes, refer to the *Effects of Excessive Historical Grazing* section in Factor A analysis for the Sierra Nevada and mountain yellow-legged frogs, above).

Livestock grazing in the Sierra Nevada has been widespread for so long that, in most places, no ungrazed areas are available to illustrate the natural condition of the habitat (Kattelman and Embury 1996, pp. 16–18). Dull (1999, p. 899) conducted stratigraphic pollen analysis (identification of pollen in sedimentary layers) in mountain

meadows of the Kern Plateau, and found significant vegetation changes attributable to sheep and cattle grazing by 1900 (though fire regime change was also implicated; see below). This degradation is widespread across the Sierra Nevada. Cooper and Wolf 2006 (p. 1) reports that 50 to 80 percent of grazed meadows now dominated by dry meadow plants were formerly wet meadows (Cooper and Wolf 2006, p. 1).

Due to the long history (Menke *et al.* 1996, Ch. 22, pp. 1–52) of livestock and packstock grazing in the Sierra Nevada and the lack of historical Yosemite toad population size estimates, it is impossible to establish a reliable quantitative estimate for the historical significance and contribution of grazing on Yosemite toad populations. However, because of the documented negative effects of livestock on Yosemite toad habitat, and the documented direct mortality caused by livestock, the decline of some populations of Yosemite toad has been attributed to the effects of livestock grazing (Jennings and Hayes 1994, pp. 50–53; Jennings 1996, pp. 921–944). Because Yosemite toad breeding habitat is generally in very shallow waters within meadows, the breeding habitat is thought to be more vulnerable to changes in hydrology caused by grazing because the small shallow pools are more easily impacted (Knapp 2002c, p. 1; Martin 2002, pp. 1–3; USFS *et al.* 2009, pp. 22, 59–62; Brown 2013, unpaginated). U.S. Geological Survey records indicate that Yosemite, Sequoia, and Kings Canyon have no meadows within the parks that are documented to have degraded hydrology (see NPS 2013, p. 7); conditions in the parks may be related to the early elimination of most grazing on national parklands in the Sierra Nevada.

## *Effects of Current Livestock Grazing*

Currently, approximately 33 percent of the estimated range of the Yosemite toad is within active USFS grazing allotments (USFS 2008, geospatial data). While stocking rates have been reduced or eliminated in most areas, legacy effects including eroded channels, soil erosion, and stream entrenchment that resulted in lowered water tables, drier meadows, and tree encroachment could still be observed in some Sierran meadows, especially in National Forests where grazing was more intense (Vankat and Major 1978, pp. 386–397). Meadow conditions in the Sierra Nevada have improved over time, but local problems could still be found as of 1985 (Ratliff 1985, pp. ii–iii) and numerous examples of head-cutting and stream incision are available within the range of the toad (Knapp 2013, unpaginated). (For additional information, see sections above pertaining to effects of grazing on the mountain yellow-legged frogs.)

The influence of grazing on toad populations in recent history is uncertain, despite more available data on land use and Yosemite toad occurrence. In 2005, the USFS, in collaboration with other researchers, began a 5-year study with multiple components to assess the effects of grazing on Yosemite toads (Allen-Diaz *et al.* 2010, pp. 1–45; Roche *et al.* 2012a, pp. 56–65; Roche *et al.* 2012b, pp. 1–11; McIlroy *et al.* 2013, pp. 1–11). Specifically, the goals of the research were to assess: (1) Whether livestock grazing under SNFPA Riparian Standards and Guidelines has a measurable effect on Yosemite toad populations and (2) effects of livestock grazing on key habitat components that affect survival and recruitment of Yosemite toad populations. SNFPA standards and guidelines

limit livestock utilization of grass and grass-like plants to a maximum of 40 percent (or a minimum 4-inch stubble height) (USDA 2004, p. 56). These companion studies did not detect an effect from grazing activity on young-of-year toad density or breeding pool occupancy, water quality, or cover (Allen-Diaz *et al.* 2010, p. 1; Roche *et al.* 2012a, p. 56; Roche *et al.* 2012b, p. 1–1; McIlroy *et al.* 2013, p. 1).

It is important to note that the results of these studies did not present a direct measurement of toad survival (for example, mark–recapture analysis of population trends), and the design was limited in numbers of years and treatment replicates. It is plausible that, for longer lived species with irregular female breeding activity over the time course of this particular study, statistical power was not sufficient to discern a treatment effect. Further, a time lag could occur between effect and discernible impacts, and significant confounding variability in known drivers such as interannual variation in climate.

Additionally, the experimental design in the studies tested the hypothesis that forest management guidelines (at 40 percent use threshold) were impacting toad populations, and this limited some analyses and experimental design to sites with lower treatment intensities. Researchers reported annual utilization by cattle ranging from 10–48 percent, while individual meadow use ranged from 0–76 percent (the SNFPA allowable use is capped at 40 percent) (Allen-Diaz *et al.* 2010, p. 5). As a result of the study design, the Allen-Diaz study does not provide sufficient information on the impacts of grazing on Yosemite toads above the prescribed management guidelines. In general, it

is not clear to what extent brief episodes of intense use (such as in cattle gathering areas) have as negative impacts on toads, or over what percentage of the grazed meadow landscape such heavier usage may occur.

The researchers observed significant variation in young-of-year occupancy in pools between meadows and years, and within meadows over years (Allen-Diaz *et al.* 2010, p. 7). This variability would likely mask treatment effects, unless the grazing variable was a dominant factor driving site occupancy, and the magnitude of the effect was quite severe. Further, in an addendum to the initial report, Lind *et al.* (2011b, pp. 12–14) report statistically significant negative (inverse) relationships for tadpole density and grazing intensity (tadpole densities decreased when percent use exceeded between 30 and 40 percent). This result supports the hypothesis that grazing at intensities approaching and above the 40 percent threshold can negatively affect Yosemite toad populations.

Allen-Diaz *et al.* (2010, p. 2) and Roche *et al.* (2012b, pp. 6–7) found that toad occupancy is strongly driven by meadow wetness (hydrology) and suggested attention should focus on contemporary factors directly impacting meadow wetness, such as climate, fire regime changes, and conifer encroachment (see Factor A above). The researchers also stated that meadow use by cattle during the grazing season is driven by selection of plant communities found in drier meadows (Allen-Diaz *et al.* 2010, p. 2). This suggests that the apparent differences in preference could provide for some segregation of toad and livestock use in meadow habitats, so that at least direct mortality

threats may be mitigated by behavioral isolation. Based on the limitations of the study as described above, we find the initial results from Allen-Diaz *et al.* (2010, pp. 1–45) to be inconclusive to discern the impacts of grazing on Yosemite toad populations where grazing and toads co-occur in meadows.

The available grazing studies focus on breeding habitat (wet meadows) and do not consider impacts to upland habitats. The USFS grazing guidelines for protection of meadow habitats of the Yosemite toad include fencing breeding meadows, but they do not necessarily protect upland habitat. Martin (2008) surveyed 11 meadow sites located along a stream channel in or near low growing willows both before and after cattle grazed the entire meadow, and Martin found that Yosemite toads could no longer be located along the stream channel after the vegetation was grazed. However, both adults and subadults could be found in dense willow thickets or in parts of the meadow that were less heavily grazed (Martin 2008, p. 298). Grazing can also degrade or destroy moist upland areas used as nonbreeding habitat by Yosemite toads (Martin 2008, p. 159), especially when nearby meadow and riparian areas have been fenced to exclude livestock. Livestock may also collapse rodent burrows used by Yosemite toads as cover and hibernation sites (Martin 2008, p. 159) or disturb toads and disrupt their behavior. Martin (2008, pp. 305–306) observed that grazing significantly reduced vegetation height at grazed meadow foraging sites, and since these areas are not protected by current grazing guidelines, deduced that cattle grazing is having a negative effect on terrestrial life stage survivorship in Yosemite toads. This problem was exacerbated as fenced areas

effectively shifted grazing activity to upland areas actively used by terrestrial life stages of the Yosemite toad (Martin 2008, p. 306).

Although we lack definitive data to assess the link between Yosemite toad population dynamics and habitat degradation by livestock grazing activity, in light of the documented impacts to meadow habitats (including effects on local hydrology) from grazing activity in general, we consider this threat prevalent with moderate impacts to the Yosemite toad and a potential limiting factor in population recovery rangewide. In addition, given the potential for negative impacts from heavy use, and the vulnerability of toad habitat should grazing management practices change with new management plans, we expect this threat to continue into the future.

#### Roads and Timber Harvest Effects to Meadow Habitat

Road construction and use, along with timber harvest activity, may impact Yosemite toad habitat via fragmentation, ground disturbance, and soil compaction or erosion (Helms and Tappeiner 1996, pp. 439–476). Roads may alter both the physical environment and the chemical environment; roads may present barriers to movement and may alter hydrologic and geomorphic processes that shape aquatic systems, while vehicle emissions and road-runoff are expected to contain chemicals that may be toxic (USFS *et al.* 2009, pp. 71–73). Timber harvests and past development of roads could potentially also lead to increased rates of siltation, contributing to the loss of breeding habitats for the Yosemite toad.



Prior to the formation of National Parks and National Forests, timber harvest was widespread and unregulated in the Sierra Nevada; however, most cutting occurred below the current elevation range of the Yosemite toad (University of California at Davis (UCD) UC 1996b, pp. 17–45; USFS *et al.* 2009, p. 77). Between 1900 and 1950, most timber harvest occurred in old-growth forests on private land (UC 1996b, pp. 17–45). During this period, forest plans often lacked standards to protect riparian areas and associated meadows, leading to harvest activities that included cutting to edges of riparian areas and forest road construction that often crossed streams, associated aquatic habitat, and meadows, and resulted in head-cutting, lowered water tables, and loss of riparian habitats; legacies of these past activities remain today (USFS *et al.* 2009, p. 77). Currently on National Forests, timber harvest and related vegetation management activities overlap with Yosemite toads primarily in the lower elevation portions of the species' range; the red fir and lodgepole forests that generally surround high-elevation meadows that are Yosemite toad habitat do not have commercial value (USFS *et al.* 2009, pp. 76, 77). Forest standards and guidelines currently provide protections for riparian areas, such as buffers for timber and vegetation management activities.

The majority of forest roads in National Forests of the Sierra Nevada were built between 1950 and 1990, to support major increases in timber harvest on National Forests, (USDA 2001a, p. 443), suggesting that many forest roads occur at elevations below the current range of the Yosemite toad. Relatively few public roads, including trans-Sierran State Highways 4 (Ebbetts Pass), 88 (Carson Pass), 108 (Sonora Pass), and 120 (Tioga

Pass), cross the high elevations of the Sierra Nevada within the range of the Yosemite toad (USFS *et al.* 2009, p. 71), although smaller public roads are present in some high-elevation areas. One percent of Yosemite toad populations occur on private lands where urbanization and corresponding construction of new roads may be more likely (USFS *et al.* 2009, p. 71); however, we are not aware of any proposals for new road construction at this time.

We expect that the majority of timber harvest, road development, and associated management impacts (see “Effects of Fire Suppression on Meadow Habitats” below) to Yosemite toad habitat took place during the expansion period in the latter half of the 20<sup>th</sup> century. Using a model, Liang *et al.* (2010, p. 16) found that Yosemite toads were more likely to occur in areas closer to timber activity, although the high correlation between elevation and the distance to harvest activity in model results definitive conclusions regarding cause and effect. However, they noted that, because timber harvest activities may maintain breeding sites by opening the forest canopy and potentially preventing encroachment of trees into sites, breeding animals might benefit from timber activity (Liang *et al.* 2010, p. 16). Limited information from timber sale areas where low-elevation populations occur indicates that such activities may negatively affect upland habitat use if burrow sites are crushed (USFS 2013, p. 6). Although ground-disturbance due to timber harvest activities has the potential to have population-level effects on Yosemite toad habitat, especially where habitat is limited, currently the best available information does not indicate that the current level of timber harvest occurring within watersheds currently inhabited by the Yosemite toad is adversely affecting habitat (USFS

*et al.* 2009, p. 77). Therefore the best available scientific and commercial information does not indicate that ongoing road construction and maintenance or timber harvest are significant threats to the Yosemite toad. There may be localized effects of these activities in areas where legacy effects continue to result in modified wet meadow habitat conditions, or where current harvest and road activities occur in close proximity to extant Yosemite toad populations.

### Effects of Fire Suppression on Meadow Habitats

Fire management refers to activities over the past century to combat forest fires. Historically, both lightning-caused fires and fires ignited by American Indians were regularly observed in western forests (Parsons and Botti 1996, p. 29), and in the latter 19<sup>th</sup> century, the active use of fire to eliminate tree canopy in favor of forage plants continued by sheepherders (Kilgore and Taylor 1979, p. 139). Beginning in the 20<sup>th</sup> century, land management in the Sierra Nevada shifted to focus on fire suppression as a guiding policy (UC 2007, p. 10).

Long-term fire suppression has influenced forest structure and altered ecosystem dynamics in the Sierra Nevada. In general, the time between fires is now much longer than it was historically, and live and dead fuels are more abundant and continuous (USDA 2001a, p. 35). Much of the habitat for the Yosemite toad occurs in high-elevation meadows within wilderness and backcountry areas where vegetation is sparse and fire suppression activities are rarely conducted (USFS *et al.* 2009, p. 55), suggesting

that fire suppression has played a limited role in such locations. At high elevations, encroachment of lodgepole pine at meadow edges has been attributed to cessation of sheep grazing or legacy effects of high-intensity grazing that reduced water tables, as opposed to fire suppression activities (Vankat and Major 1978, pp. 392–395). At lower elevations, it is not clear how habitat changes attributed to fire suppression have affected Yosemite toad populations. However, Liang *et al.* (2010, p. 16) observed that toads were less likely to occur in areas where the fire regime was significantly altered from historical conditions, and suggested that the toads are affected by some unknown or unmeasured factors related to fire management.

Evidence indicates that fire plays a significant role in the evolution and maintenance of lower elevation forested meadows of the Sierra Nevada. Under natural conditions, conifers are excluded from meadows by fire and saturated soils. Small fires thin and/or destroy encroaching conifers, while large fires are believed to determine the meadow–forest boundary (Vankat and Major 1978, p. 394; Parsons and DeBenedetti 1979, pp. 29–31). Fire is thought to be important in maintaining open aquatic and riparian habitats for amphibians in some systems (Russel *et al.* 1999, pp. 374–384), and fire suppression may have thereby contributed to conifer encroachment on meadows (Chang 1996, pp. 1071–1099; NPS 2002, p. 1). However, fire suppression effects are thought to vary with ecosystem fire regime; variable-interval fires are characteristic of the upper montane red fir forests (Chang 1996, pp. 107, 1072) that are the setting for Yosemite toad habitat at the lower elevations of its range, while long-interval fires are characteristic of the subalpine lodgepole pine forests (Chang 1996, p. 1072) that are the

setting for Yosemite toad habitats at higher elevations. The effects of fire suppression on forest structure is thought to be far less important in the longer interval forest types (Chang 1996, p. 1072).

While no studies have confirmed a link between fire suppression and rangewide population decline of the Yosemite toad, circumstantial evidence to date suggests that historic fire suppression may be a factor underlying meadow encroachment at lower elevations. The effect of fire suppression, therefore, is thought to be largely restricted to lower elevations within the Yosemite toad's range; fire suppression activities are rarely conducted where much of the habitat for the Yosemite toad occurs (USFS *et al.* 2009, pp. 51–54). Based on the best available information, we find it likely that habitat modification due to reduced fire frequency is a moderate threat to Yosemite toad in those lower-elevation areas where fire suppression has resulted in conifer encroachment into meadows.

#### Recreation and Packstock Effects to Meadow Habitat

Recreational activities take place throughout the Sierra Nevada, and they can have significant negative impacts on wildlife and their habitats (USDA 2001a, pp. 221, 453–500). Recreation can cause considerable impact to vegetation and soils in western U.S. Wilderness Areas and National Parks even with light use, with recovery occurring only after considerable periods of non-use (USFS *et al.* 2009, p. 66). Heavy foot traffic in riparian areas tramples vegetation, compacts soils, and can physically damage

streambanks. Trails (foot, horse, bicycle, or off-highway motor vehicle) can compact the soil, displace vegetation, and increase erosion, thereby potentially lowering the water table (Kondolph *et al.* 1996, pp. 1009–1026). However, the National Park Service considers current hiking and backpacking activities to be a negligible risk factor for the Yosemite toad within the Parks. The Parks have also worked to improve impacted meadows by reconstructing poorly designed trails that have degraded meadow hydrology, also identifying additional Yosemite toad meadows to prioritize additional restoration activities (NPS 2013, p. 9). Similar activities have been implemented on National Forests; for example, the Inyo National Forest has re-routed several trails to avoid the toad's breeding habitat (USFS 2013, p. 5).

Although much Yosemite toad habitat is located in wilderness or other backcountry areas removed from motorized access, the USFS has noted locations where proximity of roads or off-highway vehicle routes to Yosemite toad breeding habitat has resulted in observed impacts to Yosemite breeding habitat. Off-highway vehicles are often the first vehicles to pass through roads blocked by winter snows, occasionally driving off the road to pass remaining obstacles (USFS *et al.* 2009, p. 63). Records of such off-highway vehicle travel in breeding meadows and ponds (USFS 2013, pp. 6, 7) suggests that such activities have the potential to negatively affect these habitats, although the population-level effects to Yosemite toads are thought to be limited.

Packstock use has similar effects to those discussed for livestock grazing (for additional information on current packstock use levels and management protections, see

the Packstock Use section under the mountain yellow-legged frogs, above), although this risk factor is potentially more problematic as this land use typically takes place in more remote and higher-elevation areas occupied by Yosemite toads, and packstock tend to graze in many of the same locations that the toads prefer (USFS *et al.* 2009, p. 65). Currently, there are very few studies on the effects of packstock grazing on amphibians, especially in the Sierra Nevada. However, in Yosemite, Sequoia, and Kings Canyon National Parks, packstock use is monitored annually to prevent long-term impacts. Additionally, the NPS (2013, p. 9) has indicated that, except for a few specific areas, packstock use and Yosemite toads typically do not overlap within the Parks. Many areas are closed to packstock use entirely or limited to day use due to inadequate trail access or to protect sensitive areas. Long-term use data indicate that packstock use is declining, with no evidence to suggest that it will increase in the future (NPS 2013, pp. 6, 7). Where permitted, current guidelines in the National Parks limit trips to 20–25 animals, regulated under conditional use permits (Brooks 2012, pers. comm.). Similar standards and guidelines limit packstock group size and use within the National Forests (USFS 2013, pp. 3–5).

Habitat-related effects of recreational activities on the Yosemite toad may have population-level impacts in localized areas and under site-specific conditions, for example, where foot traffic adjacent to occupied meadows is exceptionally heavy and results in meadow damage, where legacy effects of high recreation use have resulted in continuing meadow damage, or where off-highway vehicle use results in changes in meadow hydrology. However, in general, we do not consider habitat-related changes

associated with current levels of hiking or backpacking to pose a population-level risk to Yosemite toads. Therefore, at this time we consider recreational activities to be a low prevalence threat across the range of the Yosemite toad.

#### Dams and Water Diversions Effects to Meadow Habitat

Past construction of dams, diversion, and irrigation ditches resulted in a vast man-made network that altered local and regional stream hydrology in the Sierra Nevada (SNEP 1996, p. 120), although, with the exception of several dozen small impoundments and diversions, almost all of these are located below the range of the Yosemite toad (USFS *et al.* 2009, pp. 76, 77). However, in the past a small number of reservoirs were constructed within the historic range of the Yosemite toad, most notably Upper and Lower Blue Lakes, Edison, Florence, Huntington, Courtright, and Wishon Reservoirs. Construction of several high-elevation reservoirs (for example, Edison and Florence) is thought to have inundated shallow-water breeding habitat for the toad (USFS *et al.* 2009, pp. 76, 77). Where reservoirs are used for hydroelectric power, water-level declines caused by drawdown of reservoirs can lead to the mortality of eggs and tadpoles by stranding and desiccation, although, with the exception of Blue Lakes, Yosemite toads are currently not known from the above reservoirs (USFS *et al.* 2009, pp. 78, 79).

Past construction of these reservoirs likely contributed to the decline of the Yosemite toad in the area where they were built. Increasing effects from climate change, or new water supply development in response to such effects, may exacerbate this risk in



the future if new reservoirs are constructed within areas occupied by the toad. However, we are not aware of any proposals to construct additional reservoirs within the Yosemite toads range. We expect that continuing reservoir operations may have continued habitat-related effects to toad populations in these developed areas, but less so in the current extent of the Yosemite toad's (remnant) range. Therefore, we consider this threat to be of low prevalence to the Yosemite toad across its range.

#### Climate Effects to Meadow Habitat

Different studies indicate that multiple drivers are behind the phenomenon of conifer encroachment into meadows. The first factor affecting the rate of conifer encroachment into meadow habitats, fire suppression, was discussed above. Climate variability is another factor affecting the rate of conifer encroachment on meadow habitats. A study by Franklin *et al.* (1971, p. 215) concluded that fire had little influence on meadow maintenance in their study area, while another study concluded that climate change is a more likely explanation for encroachment of trees into the adjacent meadow at their site, rather than fire suppression or changes in grazing intensity (Dyer and Moffett, 1999, p. 444).

Climatic variability is strongly correlated with tree encroachment into dry subalpine meadows (Jakubos and Romme 1993, p. 382). In the Sierra Nevada, most lodgepole pine seedlings become established during years of low snowpack when meadow soil moisture is reduced (Wood 1975, p. 129). The length of the snow-free

period may be the most critical variable in tree invasion of subalpine meadows (Franklin *et al.* 1971, p. 222), with the establishment of a good seed crop, followed by an early snowmelt, resulting in significant tree establishment. It is apparent that periods of low snowpack and early melt may in fact be necessary for seedling establishment (Ratliff, 1985, p. 35). Millar *et al.* (2004, p. 181) reported that increased temperature, coupled with reduced moisture availability in relation to large-scale temporal shifts in climate, facilitated the invasion of 10 subalpine meadows studied in the Sierra Nevada.

Our analyses under the Act include consideration of ongoing and projected changes in climate. The terms “climate” and “climate change” are defined by the Intergovernmental Panel on Climate Change (IPCC). “Climate” refers to the mean and variability of different types of weather conditions over time, with 30 years being a typical period for such measurements, although shorter or longer periods also may be used (IPCC 2007, p. 1450; IPCC 2013a, Annex III). The term “climate change” thus refers to a change in the mean or variability of one or more measures of climate (for example, temperature or precipitation) that persists for an extended period, typically decades or longer, whether the change is due to natural variability, human activity, or both (IPCC 2007, p. 1450; IPCC 2013a, Annex III). A recent compilation of climate change and its effects is available from reports of the Intergovernmental Panel on Climate Change (IPCC) (IPCC 2013b, entire). Various types of changes in climate can have direct or indirect effects on species. These effects may be positive, neutral, or negative, and they may change over time, depending on the species and other relevant considerations, such as the effects of interactions of climate with other variables (for

example, habitat fragmentation) (IPCC 2007, pp. 8–14, 18–19). In our analyses, we use our expert judgment to weigh relevant information, including uncertainty, in our consideration of various aspects of climate change.

For the Sierra Nevada ecoregion, climate models predict that mean annual temperatures will increase by 1.8 to 2.4 °C (3.2 to 4.3 °F) by 2070, including warmer winters with earlier spring snowmelt and higher summer temperatures (PRBO 2011, p. 18). Additionally, mean annual rainfall is projected to decrease from the current average by some 9.2–33.9 cm (3.6–13.3 in) by 2070 (PRBO 2011, p. 18). However, projections have high uncertainty, and one study predicts the opposite effect (PRBO 2011, p. 18). Snowpack is, by all projections, going to decrease dramatically (following the temperature rise and increase in precipitation falling as rain) (PRBO 2011, p. 19); (Kadir *et al.* 2013, pp. 76–80). Higher winter stream flows, earlier runoff, and reduced spring and summer stream flows are projected, with increasing severity in the southern Sierra Nevada (PRBO 2011, pp. 20–22); (Kadir *et al.* 2013, pp. 71–75).

Snow-dominated elevations from 2,000–2,800 m (6,560–9,190 ft) will be the most sensitive to temperature increases (PRBO 2011, p. 23). Meadows fed by snowmelt may dry out or be more ephemeral during the non-winter months (PRBO 2011, p. 24). This pattern could influence groundwater transport, and springs may be similarly depleted, leading to lower water levels in available breeding habitat and decreased area and hydroperiod (i.e., duration of water retention) of suitable habitat for rearing tadpoles

of Yosemite toads. Changes in water transport may promote channel incision and result in a shift to non-meadow conditions (Viers *et al.* 2013, p. 31).

Blaustein *et al.* (2010, pp. 285–300) provide an exhaustive review of potential direct and indirect and habitat-related effects of climate change to amphibian species, with documentation of effects in a number of species where such effects have been studied. Altitudinal range shifts with changes in climate have been reported in some regions. They note that temperature can influence the concentration of dissolved oxygen in aquatic habitats, with warmer water generally having lower concentrations of dissolved oxygen, and that water balance heavily influences amphibian physiology and behavior. They predict that projected changes in temperature and precipitation are likely to increase habitat loss and alteration for those species living in sensitive habitats, such as ephemeral ponds and alpine habitats (Blaustein *et al.* 2010, pp. 285–287).

Because environmental cues such as temperature and precipitation are clearly linked to onset of reproduction in many species, climate change will likely affect the timing of reproduction in many species, potentially with different sexes responding differently to climate change. For example, males of two newt species (*Triturus* spp.) showed a greater degree of change in arrival date at breeding ponds (Blaustein *et al.* 2010, p. 288). Lower concentrations of dissolved oxygen in aquatic habitats may negatively affect developing embryos and larvae, in part because increases in temperature increase the oxygen consumption rate in amphibians. Reduced oxygen concentrations have also been shown to result in accelerated hatching in ranid frogs, but at a smaller

size, while larval development and behavior may also be affected and may be mediated by larval density and food availability (Blaustein *et al.* 2010, pp. 288–289).

Increased temperatures can reduce time to metamorphosis, which can increase chances of survival where ponds dry, but also result in metamorphosis at a smaller size, suggesting a likely trade-off between development and growth, which may be exacerbated by climate change and have fitness consequences for adults (Blaustein *et al.* 2010, pp. 289–290). Changes in terrestrial habitat, such as changed soil moisture and vegetation, can also directly affect adult and juvenile amphibians, especially those adapted to moist forest floors and cool, highly oxygenated water that characterizes montane regions. Climate change may also interact with other stressors that may be acting on a particular species, such as disease and contaminants (Blaustein *et al.* 2010, pp. 290–299).

A recent paper (Kadir *et al.* 2013, entire) provides specific information on the effects of climate change in the Sierra Nevada. The report found that glaciers in the Sierra Nevada have decreased in area over the past century, and glacier shrinkage results in earlier peak water runoff and drier summer conditions. Another result from the report is that the lower edge of the conifer-dominated forests in the Sierra Nevada has been retreating upslope over the past 60 years. Regarding wildfire, since 1950, annual acreage burned in wildfires statewide has been increasing in California, and in the western United States, large wildfires have become more frequent, increasing in tandem with rising spring and summer temperatures. Finally, the report found that today's subalpine forests

in the Sierra Nevada are much denser—that is, comprise more small-diameter trees—than they were over 70 years ago. During this time period, warmer temperatures, earlier snowmelt, and more rain than snow occurred in this region. Many of these changes in the Sierra Nevada of California due to climate are likely to influence Yosemite toads because they are highly vulnerable to climate change because changing hydrology and habitat in the Sierra Nevada will likely have impacts on remaining populations (Viers *et al.* 2013, pp. 55, 56).

Historically, drought is thought to have contributed to the decline of the Yosemite toad (Kagarise Sherman and Morton 1993, p. 186; Jennings and Hayes 1994, pp. 50–53). Extended and more severe droughts pose an ongoing, rangewide risk to the species and are expected to increase with predicted climate changes (PRBO 2011, p. 18). Such changes may reduce both the amount of suitable breeding habitat and the length of time that suitable water is available in that habitat (Brown 2013, unpaginated).

Davidson *et al.* (2002, p. 1598) analyzed geographic decline patterns for the Yosemite toad. They compared known areas of extirpation against a hypothesized model for climate change that would predict greater numbers of extirpations at lower altitudes, and in more southern latitudes. The researchers did not observe a pattern in the available historic data to support the climate change hypothesis as a driver of historic population losses, although they acknowledge that climate change may be a contributor in more complex or subtle ways. Additionally, this study was limited by small sample size, and it is possible that climate change effects on the Yosemite toad (a long-lived species) may

not become evident for many years (USFS *et al.* 2009, p. 48). Finally, Davidson *et al.* (2002, p. 1598) did find an increase in occupancy with elevation (greater densities of populations at altitude), and this observation is consistent with a pattern that would fit a response to climate change (USFS *et al.* 2009, p. 48). However, this observation would also be consistent if the features of these particular habitats (such as at higher elevation) were more suited to the special ecological requirements of the toad, or if other stressors acting on populations at lower elevations were responsible for the declines. We, therefore, find these results inconclusive.

Most recently, modeled vulnerability assessments for Sierra Nevada montane meadow systems have utilized life history and habitat requirements to gauge vulnerability of amphibian species to climate change. This assessment indicates that vulnerability to hydro-climatic changes will likely be very high for the Yosemite toad, and that continued or worsening stream channelization in montane meadows from flashy storms may worsen effects by further reductions in the water table (Viers *et al.* 2013, p. 56).

The breeding ecology and life history of the Yosemite toad are that of a habitat specialist, as it utilizes pool and meadow habitats during the onset of snowmelt and carefully times its reproduction to fit available conditions within ephemeral breeding sites. The most striking documented declines in Yosemite toad populations in the historical record are correlated with extreme climate episodes (drought) (Kagarise Sherman and Morton 1993, pp. 186–198). Given these observations, it is likely that climate change (see also discussion in mountain yellow-legged frog's **Summary of**

**Factors Affecting the Species**, under Factor E) poses a significant risk to the Yosemite toad now and in the future. It is quite possible that these impacts are occurring currently, and have occurred over the last few decades. However, it is difficult in short time intervals to discern the degree of effect from climate change within the variability of natural climate cycles.

In summary, based on the best available scientific and commercial information, we consider the threats of destruction, modification, and curtailment of the species' habitat and range to be significant ongoing threats to the Yosemite toad. The legacy effects of past land uses have altered meadow communities through the mechanism of stream incision by permanently reducing habitat quantity and quality unless active and costly restoration is implemented. Climate change is a current threat of high magnitude. Threats considered of moderate magnitude include livestock grazing and fire management regime. Threats considered currently low magnitude include roads and timber harvest, dams and water diversions, and recreational land uses.

*Factor B. Overutilization for Commercial, Recreational, Scientific, or Educational Purposes*

We do not have any scientific or commercial information to indicate that overutilization for commercial, recreational, or scientific purposes poses a threat to the Yosemite toad. There is currently no known commercial market for Yosemite toads, although one pet store in Los Angeles that is no longer in business had previously sold at



least one Yosemite toad (USFS *et al.* 2009, pp. 65–66); and there is also no documented recreational or educational use for Yosemite toads.

Scientific research may cause some stress to Yosemite toads through disturbance and disruption of behavior, handling, and injuries associated with marking individuals. This activity has resulted in the known death of individuals through accidental trampling (Green and Kagarise Sherman 2001, pp. 92–103), irradiation from radioactive tags (Karlstrom 1957, pp. 187–195), and collection for museum specimens (Jennings and Hayes 1994, pp. 50–53). We expect that requirements for Federal (USFS and NPS) and State (CDFW) research and special use permits, and University ethics requirements provide some protections for wildlife-research subjects and limit negative effects to individuals. Therefore, we do not currently consider ongoing and future scientific research to be a threat to the Yosemite toad. We also anticipate that further research into the genetics and life history of the Yosemite toad and broader methodological censuses will provide a net conservation benefit to this under-studied species.

Based on the best available scientific and commercial information, we do not consider overutilization for commercial, recreational, scientific, or educational purposes to be a threat to the Yosemite toad.

#### *Factor C. Disease or Predation*

##### Predation

Prior to the trout stocking of high Sierra Nevada lakes, which began over a century ago, fish were entirely absent from most of this region (Bradford 1989, pp. 775–778). Observations regarding the effects of introduced fishes on the Yosemite toad are mixed. However, re-surveys of historical Yosemite toad sites have shown that the species has disappeared from several lakes where they formerly bred, and these areas are now occupied by fish (Stebbins and Cohen 1995, pp. 213–215; Martin 2002, p. 1).

Drost and Fellers (1994, pp. 414–425) suggested that Yosemite toads are less vulnerable to fish predation than frogs because they breed primarily in ephemeral waters that do not support fish. Further, Jennings and Hayes (1994, pp. 50–53) stated that the palatability of Yosemite toad tadpoles to fish predators is unknown, but often assumed to be low based on the unpalatability of western toads (Drost and Fellers 1994, pp. 414–425; Kiesecker *et al.* 1996, pp. 1237–1245), to which Yosemite toads are closely related. Grasso (2005, p. 1) observed brook trout swimming near, but the trout ignored Yosemite toad tadpoles, suggesting that tadpoles are unpalatable. The study also found that subadult Yosemite toads were not consumed by brook trout (Grasso 2005, p. 1), although the sublethal effects of trout “sampling” (mouthing and ejecting tadpoles) and the palatability of subadults to other trout species are unknown. Martin (2002, p. 1) observed brook trout preying on Yosemite toad tadpoles, and also saw them “pick at” Yosemite toad eggs (which later became infected with fungus). In addition, metamorphosed western toads have been observed in golden trout stomach contents (Knapp 2002c, p. 1). Nevertheless, Grasso *et al.* (2010, p. 457) concluded that early life stages of the Yosemite

toad likely possess chemical defenses that provide sufficient protection from native trout predation.

The observed predation of Yosemite toad tadpoles by trout (Martin 1992, p. 1) indicates that introduced fishes may pose a predation risk to the species in some situations, which may be accentuated during drought years. At a site where Yosemite toads normally breed in small meadow ponds, they have been observed to successfully switch breeding activities to stream habitat containing fish during years of low water (Strand 2002, p. 1). Thus, drought conditions may increase the toads' exposure to predatory fish, and place them in habitats where they compete with fish for invertebrate prey. Additionally, although the number of lake breeding sites used by Yosemite toads is small relative to the number of ephemeral sites, lake sites may be especially important because they are more likely to be habitable during years with low water (Knapp 2002c, p. 1).

Overall, the data and available literature suggest that direct mortality from fish predation is likely not an important factor driving Yosemite toad population dynamics. This does not discount other indirect impacts, such as the possibility that fish may be effective disease vectors (see below). Yosemite toad use of more ephemeral breeding habitats (which are less habitable to fish species as they cannot tolerate drying or freezing) minimizes the interaction of fish and toad tadpoles. Further, where fish and toads co-occur, it is possible that food depletion (outcompetition) by fish negatively affects Yosemite toads (USFS *et al.* 2009, p. 58).

Other predators may also have an effect on Yosemite toad populations. Kagarise Sherman and Morton (1993, p. 194) reported evidence of toad predation by common ravens (*Corvus corax*) and concluded this activity was responsible for the elimination of toads from one site. These researchers also confirmed, as reported in other studies, predation on Yosemite toad by Clark's nutcrackers (*Nucifraga columbiana*). The significance of avian predation may increase if the abundance of common ravens within the current range of the Yosemite toad increases as it has in nearby regions (Camp *et al.* 1993, p. 138; Boarman *et al.* 1995, p. 1; Kelly *et al.* 2002, p. 202). However, the degree to which avian predation may be affecting Yosemite toad populations has not been quantified.

## Disease

Although not all vectors have been confirmed in the Sierra Nevada, introduced fishes, humans, pets, livestock, packstock, vehicles, and wild animals may all act to facilitate disease transmission between amphibian populations. Infection of both fish and amphibians by a common disease has been documented with viral (Mao *et al.* 1999, pp. 45–52) and fungal pathogens in the western United States (Blaustein *et al.* 1994b, pp. 251–254). Mass die-offs of amphibians in the western United States and around the world have been attributed to Bd fungal infections of metamorphs and adults (Carey *et al.* 1999, pp. 1–14), *Saprolegnia* fungal infections of eggs (Blaustein *et al.* 1994b, pp. 251–254), ranavirus infections, and bacterial infections (Carey *et al.* 1999, pp. 1–14).

Various diseases are confirmed to be lethal to Yosemite toads (Green and Kagarise Sherman 2001, pp. 92–103), and recent research has elucidated the potential role of Bd infection as a threat to Yosemite toad populations (Dodge and Vredenburg 2012, p. 1). These various diseases and infections, in concert with other factors, have likely contributed to the decline of the Yosemite toad (Kagarise Sherman and Morton 1993, pp. 193–194) and may continue to pose a risk to the species (Dodge and Vredenburg 2012, p. 1).

Die-offs in Yosemite toad populations have been documented in the literature, and an interaction with diseases in these events has been confirmed. However, no single cause has been validated by field studies. Tissue samples from dead or dying adult Yosemite toads and healthy tadpoles were collected during a die-off at Tioga Pass Meadow and Saddlebag Lake and analyzed for disease (Green and Kagarise Sherman 2001, pp. 92–103). Six infections were found in the adults, including infection with Bd, bacillary bacterial septicemia (red-leg disease), *Dermosporidium* (a fungus), myxozoa spp. (parasitic cnidarians), *Rhabdias* spp. (parasitic roundworms), and several species of trematode (parasitic flatworms). Despite positive detections, no single infectious disease was found in more than 25 percent of individuals, and some dead toads showed no signs of infection to explain their death. Further, no evidence of infection was found in tadpoles. A meta-analysis of red-leg disease also revealed that the disease is a secondary infection that may be associated with a suite of different pathogens, and so actual causes of decline in these instances were ambiguous (Kagarise Sherman and Morton 1993, p.

194). The authors concluded that the die-off was caused by suppression of the immune system caused by an undiagnosed viral infection or chemical contamination that made the toads susceptible to the variety of diagnosed infections.

*Saprolegnia ferax*, a species of water mold that commonly infects fish in hatcheries, caused a massive lethal infection of eggs of western toads at a site in Oregon (Blaustein *et al.* 1994b, p. 252). It is unclear whether this event was caused by the introduction of the fungal pathogen via fish stocking, or if the fungus was already present and the eggs' ability to resist infection was inhibited by some unknown environmental factor (Blaustein *et al.* 1994b, p. 253). Subsequent laboratory experiments have shown that the fungus could be passed from hatchery fish to western toads (Kiesecker *et al.* 2001, pp. 1064–1070). Fungal growth on Yosemite toad eggs has been observed in the field, but the fungus was not identified and it was unclear whether the fungus was the source of the egg mortality (Kagarise Sherman 1980, p. 46). Field studies conducted in Yosemite National Park found that an undetermined species of water mold infected only the egg masses that contained dead embryos of Yosemite toads (Sadinski 2004, pp. 33–34). The researchers also observed that the water mold became established on egg masses only after embryo death, and subsequently spread, causing the mortality of additional embryos of Yosemite toads.

Sadinski (2004, p. 35) discovered that mortality of Yosemite toad embryos may be attributed to an unidentified species of a free-living flatworm (*Turbellaria* spp.). In Yosemite National Park, these worms were observed to penetrate Yosemite toad egg

masses and feed directly on the embryos. In some locations, *Turbellaria* spp. reached such large densities that they consumed all the embryos within a Yosemite toad egg mass. Predation also facilitated the colonization and spread of water mold on egg masses, leading to further embryo mortality. Further studies would be needed to determine which species of *Turbellaria* feeds on Yosemite toad eggs, and the extent of this impact on Yosemite toad populations.

Until recently, the contribution of Bd infection to Yosemite toad population declines was relatively unknown. Although the toad is hypothetically susceptible due to co-occurrence with the mountain yellow-legged frog, the spread and growth of Bd in the warmer pool habitats, occupied for a much shorter time relative to the frog, is suspected to render individuals less prone to epidemic outbreaks (USFS *et al.* 2009, p. 50). Fellers *et al.* (2011, p. 391) documented the occurrence of Bd infection in Yosemite National Park toads over at least a couple of decades, and they note population persistence in spite of the continued presence of the pathogen. In a survey of 196 museum specimens, Dodge and Vredenburg (2012, p. 1) report the first presence of Bd infection in Yosemite toads beginning in 1961, with the pathogen becoming highly prevalent during the recorded declines of the late 1970s, before it peaked in the 1990s at 85 percent positive incidence. In live specimen sampling, Dodge and Vredenburg (2012, p. 1) collected 1,266 swabs of Yosemite toads between 2006 and 2011, and found Bd infection intensities at 17–26 percent (with juvenile toads most affected). The studies detected a pattern indicative of the historic emergence of Bd, which coincided with the documented decline in Yosemite toad (Dodge 2013, p. 1). As such, results from these studies support the hypothesis that

Bd infection and chytridiomycosis have played an important role in Yosemite toad population dynamics over the period of their recent recorded decline.

Carey (1993, pp. 355–361) developed a model to explain the disappearance of boreal toads (*Bufo boreas boreas*) in the Rocky Mountains, suggesting immune system suppression from extreme winter stress (“winter stress syndrome”) could have contributed to the decline in that species. This model may also fit Yosemite toad die-offs observed by Kagarise Sherman and Morton (1993, pp. 186–198), given the close relationship between the two toads, and their occupation of similar habitats. However, an analysis of immune system suppression and the potential role of winter stress relative to Yosemite toad population trends is not available at this time. Yet, the decline pattern observed in the Carey study is mirrored by the pattern in the Yosemite toad (heavy mortality exhibited in males first) (Knapp 2012, pers. comm.). This observation, in concert with the recent results from museum swabs (Dodge and Vredenburg 2012, p. 1), provides a correlative link to the timing of the recorded Yosemite toad declines and Bd infection intensities.

Although disease as a threat factor to the Yosemite toad is relatively less documented, Bd infection causes mass mortalities in the closely related boreal toad (Carey et al. 2006, p. 19) and there is evidence related to Bd’s role in historical die-offs in Yosemite toads. Much of the historic research documenting Yosemite toad declines predated our awareness of Bd as a major amphibian pathogen. Additionally, the life history of the Yosemite toad, as a rapid breeder during early snowmelt, limits the



opportunities to observe population crashes in the context of varied environmental stressors. Currently available evidence indicates that Bd was likely a significant factor contributing to the recent historical declines observed in Yosemite toad populations (Dodge and Vredenburg 2012, p. 1). Although infection intensities are currently lower than some peak historic measurements, this threat remains a potential factor that may continue to reduce survival through metamorphosis, and therefore recruitment to the breeding population (Knapp 2012, pers. comm.). Additionally, the interaction of disease and other stressors, such as climate extremes, is not well understood in the Yosemite toad. Research does suggest that the combination of these threats represents a factor in the historical decline of the species (Kagarise Sherman and Morton 1993, p. 186).

In summary, based on the best available scientific and commercial information, we do not consider predation to be a threat to the species. We consider disease to be a threat to the Yosemite toad that has a moderate, ongoing effect on populations of the species rangewide. The threat most specifically includes the amphibian pathogen, Bd. Although definitive empirical data quantifying the contribution of disease to Yosemite toad population declines are not currently available, population declines that were concurrent with the prevalence and spread of Bd across the Sierra Nevada support the assertion that disease has played a role in the observed trend. Further, Bd infection, even at lower intensities, may interact with climate extremes and continue to depress recruitment of yearling and subadult Yosemite toads to breeding Yosemite toad populations. We suspect this threat was historically significant, that it is currently having a moderate influence on toad populations, and we expect it to be a future concern.

#### *Factor D. The Inadequacy of Existing Regulatory Mechanisms*

In determining whether the inadequacy of regulatory mechanisms constitutes a threat to the Yosemite toad, we analyzed the existing Federal and State laws and regulations that may address the threats to the species or contain relevant protective measures. Regulatory mechanisms are typically nondiscretionary and enforceable, and may preclude the need for listing if such mechanisms are judged to adequately address the threat(s) to the species such that listing is not warranted. Conversely, threats on the landscape are not addressed by existing regulatory mechanisms where the existing mechanisms are not adequate (or not adequately implemented or enforced).

We discussed the applicable State and Federal laws and regulations, including the Wilderness Act, NFMA above (see Factor D discussion for mountain yellow-legged frogs). In general, the same administrative policies and statutes are in effect for the Yosemite toad. This section additionally addresses regulatory mechanisms with a specific emphasis on the Yosemite toad.

#### *Taylor Grazing Act of 1934*

In response to overgrazing of available rangelands by livestock from the 1800s to the 1930s, Congress passed the Taylor Grazing Act in 1934 (43 U.S.C. 315 *et seq.*). This action was an effort to stop the damage to the remaining public lands as a result of

overgrazing and soil depletion, to provide coordination for grazing on public lands, and to attempt to stabilize the livestock industry (Meehan and Platts 1978, p. 275; *Public Lands Council et al. v. Babbitt Secretary of the Interior et al.* (167 F. 3d 1287)). Passage of the Taylor Grazing Act resulted in reduced grazing in some areas, including the high Sierra Nevada. However, localized use remained high, precluding regeneration of many meadow areas (Beesley 1996, p. 14; Menke *et al.* 1996, p. 14; *Public Lands Council et al. v. Babbitt Secretary of the Interior et al.* (167 F. 3d 1287)).

Existing Federal and State laws and regulatory mechanisms currently offer some level of protection for the Yosemite toad. Specifically, these include the Wilderness Act, the NFMA, the SNFPA, and the FPA (see Factor D discussion for mountain yellow-legged frog complex). Based on the best available scientific and commercial information, we do not consider the inadequacy of existing regulatory mechanisms to be a threat to the Yosemite toad.

#### *Factor E. Other Natural or Manmade Factors Affecting Its Continued Existence*

The Yosemite toad is sensitive to environmental change or degradation due to its life history, biology, and existence in ephemeral habitats characterized by climate extremes and low productivity. It is also sensitive to anthropogenically influenced factors. For example, contaminants, acid precipitation, ambient ultraviolet radiation, and climate change have been implicated as contributing to amphibian declines (Corn 1994, pp. 62–63; Alford and Richards 1999, pp. 2–7). However, as with the case with the

mountain yellow-legged frog complex, contaminants, acid precipitation, and ambient ultraviolet radiation are not known to pose a threat (current or historical) to Yosemite toad and, therefore, are not discussed further. Please refer to the proposed listing rule for the Sierra Nevada yellow-legged frog, the northern DPS of the mountain yellow-legged frog, and the Yosemite toad (78 FR 24472, April 25, 2013) for a detailed discussion of contaminants, acid precipitation, and ambient ultraviolet radiation. The following discussion will focus on potential threat factors specifically studied in the Yosemite toad, based on the unique life history, population status, demographics, or biological factors specific to Yosemite toad populations.

#### Climate Change Effects on Individuals

As discussed above in Factor A, climate change can result in detrimental impacts to Yosemite toad habitat. Climate variability could also negatively impact populations through alteration of the frequency, duration, and magnitude of either droughts or severe winters (USFS *et al.* 2009, p. 47). Yosemite toads breed and their tadpoles develop in shallow meadow and ephemeral habitats, where mortality from desiccation and freezing can be very high, often causing complete loss of an annual cohort (USFS *et al.* 2009, p. 10). Kagarise Sherman and Morton (1993, pp. 192–193) documented in a long-term population study that Yosemite toad hatching success and survival were subject to a balance between the snowpack water contribution to breeding pools and the periodicity and character of breeding season storms and post-breeding climate (whether it is cold or warm). When it is too cold, eggs and tadpoles are lost to freezing. This situation poses a

risk as earlier snowmelt is expected to cue breeding earlier in the year, exposing young tadpoles (or eggs) to killing frosts in more variable conditions of early spring (Corn 2005, p. 60). When it is too dry, tadpoles are lost to pool desiccation. Alterations in the annual and seasonal hydrologic cycles that influence water volume and persistence in Yosemite toad breeding areas can thereby impact breeding success. The threat of climate change on individuals is significant, and is of high prevalence now and into the future.

#### Other Sources of Direct and Indirect Mortality

Direct and indirect mortality of Yosemite toads has occurred as a result of livestock grazing. Mortality risk from livestock trampling is expected to be the greatest for non-larval stages where livestock concentrate in Yosemite toad habitat when toad densities are highest; early in the season when breeding adults are aggregated and egg masses are laid; and at metamorphosis when juveniles are metamorphosing in mass along aquatic margins. However, because cattle typically are not present during the breeding season, the risk of trampling is expected to be greatest for metamorphs (USFS *et al.* 2009, p. 59). Cattle have been observed to trample Yosemite toad metamorphs and subadult toads, and these life stages can fall into deep hoofprints and die (Martin 2008, p. 158). Specifically, Martin (2008, p. 158) witnessed some 60 subadult and metamorph toad deaths during the movement of 25 cattle across a stream channel bordered by willows within a meadow complex. Adult Yosemite toads trampled to death by cattle have also been observed (Martin 2002, pp. 1–3). This risk factor is likely of sporadic significance, and is of greatest concern where active grazing allotments coincide with breeding

meadows. However, it is difficult to determine the degree of this impact without quantitative data.

Trampling and collapse of rodent burrows by recreationists, pets, and vehicles could lead to direct mortality of terrestrial life stages of the Yosemite toad. Recreational activity may also disturb toads and disrupt their behavior (Karlstrom 1962, pp. 3–34). Recreational anglers may be a source of introduced pathogens and parasites, and they have been observed using toads and tadpoles as bait (USFS *et al.* 2009, p. 66). However, Kagarise Sherman and Morton (1993, p. 196) did not find a relationship between the distance from the nearest road and the declines in their study populations, suggesting that human activity was not the cause of decline in that situation. Recreational activity may be of conservation concern, and this threat may increase with greater activity in mountain meadows. However, current available information does not indicate that recreational activity is a significant stressor for Yosemite toads.

Fire management practices over the last century have created the potential for severe fires in the Sierra Nevada. Wildfires do pose a potential direct mortality threat to Yosemite toads, although amphibians in general are thought to retreat to moist or subterranean refuges and thereby suffer low mortality during natural fires (Russel *et al.* 1999, pp. 374–384). In the closely related boreal toad (*Bufo boreas*), Hossack and Corn (2007, p. 1409) documented a positive response (increase in occupied breeding sites and population size) following a wildfire, with returns to near pre-fire occupancy levels after 4 to 5 years (Hossack *et al.* 2012, p. 224), suggesting that habitat-related changes

associated with wildfires may provide at least short-term benefits to Yosemite toad populations. However, data on the direct and indirect effects of fire on Yosemite toads are lacking.

USFS *et al.* (2009, p. 74) suggested that the negative effects of roads that have been documented in other amphibians, in concert with the substantial road network across a portion of the Yosemite toad's range, indicate this risk factor may be potentially significant to the species. Roads may facilitate direct mortality of amphibians through vehicle strikes (DeMaynadier and Hunter 2000, pp. 56–65), and timber harvest activities (including fuels management and vegetation restoration activities) have been documented to result in the direct mortality of Yosemite toads (USFS 2013, p. 94). Levels of timber harvest and road construction have declined substantially since implementation of the California Spotted Owl Sierran Province Interim Guidelines in 1993, and some existing roads have been decommissioned or are scheduled to be decommissioned (USDA 2001a, p. 445). Therefore, the risks posed by new roads and timber harvests have declined, but those already existing still may pose risks to the species and its habitat.

Toads could potentially be trampled or crushed by activities implemented to reduce fire danger. USFS *et al.* (2009, p. 53) report that the Forest Service has initiated a fuels reduction program in order to reduce the extent and intensity of wildfires. However, most of these projects will occur in the Wildland Urban Interface, which is below the elevational range of the Yosemite toad and generally near human developments. However, in the future some fuels projects may occur in limited areas

around facilities, such as resorts, pack stations, or summer homes, within the lowest portion of the Yosemite toad range.

Collectively, direct mortality from land uses within the Yosemite toad range may have impacts to the toad. However, we are aware of no studies that have quantified or estimated the prevalence of this particular threat to be able to assess its impact to Yosemite toad populations. At the current time, direct and indirect mortality from roads are not considered to be a significant factor affecting the Yosemite toad rangewide.

#### Small Population Size

Although it is believed that the range of the Yosemite toad has not significantly contracted, the majority of populations across this area have been extirpated, and this loss has been significant relative to the historical condition (multitudes of populations within many watersheds across their geographic range) (see “Population Estimates and Status” above). Further, growing evidence suggest that the populations that remain are small, numbering fewer than 20 males in most cases (Kagrise Sherman and Morton 1993, p. 190; Sadinski 2004, p. 40; Brown *et al.* 2012, p. 125). This situation renders these remnant populations susceptible to risks inherent to small populations (see Factor E discussion, “Small Population Size,” for mountain yellow-legged frogs, above) including inbreeding depression and genetic drift, along with a higher probability of extirpation from unpredictable events such as severe storms or extended droughts.



Traill *et al.* (2009, p. 32) argued for a benchmark viable population size of 5,000 adult individuals (and 500 to prevent inbreeding) for a broad range of taxa, although this type of blanket figure has been disputed as an approach to conservation (Flather *et al.* 2011, pp. 307–308). Another estimate, specific to amphibians, is that populations of at least 100 individuals are less susceptible to demographic stochasticity (Schad 2007, p. 10). Amphibian species with highly fluctuating population size, high frequencies of local extinctions, and living in changeable environments may be especially susceptible to curtailment of dispersal and restriction of habitat (Green 2003, p. 331). These conditions are all likely applicable to the Yosemite toad.

Therefore, based on the best available commercial and scientific information, we conclude that small population size is a prevalent and significant threat to the species viability of the Yosemite toad across its range, especially in concert with other extant stressors (such as climate change).

### Cumulative Impacts of Extant Threats

Interactive effects or cumulative impacts from multiple additive stressors acting upon Yosemite toad populations over time are indicated by the documented declines in populations and abundance across the range of the species. Although no single causative factor linked to population declines in Yosemite toads has been confirmed in the literature (excepting perhaps extreme climate conditions such as droughts) (Kagarise Sherman and Morton 1993, p. 186; Jennings and Hayes 1994, pp. 50–53), there has been

a decline in population abundance and numbers of extant populations inhabiting the landscape (Brown *et al.* 2012, pp. 115–131; Kagarise Sherman and Morton 1993, pp. 186–198). This pattern of decline suggests a factor or combination of factors common throughout the range of the toad. The available literature (Kagarise Sherman and Morton 1993, pp. 186–198; Jennings and Hayes 1994, pp. 50–53; USFS *et al.* 2009, pp. 1–133; Martin 2008, pp. *i*–393) supports the contention that a combination of factors has interacted and is responsible for the decline observed in Yosemite toad populations over the past few decades.

Disease has been documented in Yosemite toad populations, and recent data documenting historic trends in Bd infection intensity are compelling (Dodge and Vredenburg 2012, p. 1), but disease has not been definitively tied to the observed rangewide decline. There is considerable evidence that various stressors, mediated via impacts to meadow hydrology following upslope land management practices over the last century, have detrimentally affected the quantity and quality of breeding meadows. Many of these stressors, such as grazing, have been more significant in the past than under current management standards. However, legacy effects remain, and meadows tend not to recover without active intervention once excessive stream incision in their watershed is set in motion (Vankat and Major 1978, pp. 386–397). Certain stressors may be of concern, such as recreational impacts and avian predation upon terrestrial life stages of toads, although we do not have sufficient data to document the magnitude of these particular stressors.

Given the evidence supporting the role of climate in reducing populations and potentially leading to the extirpation of many of the populations studied through the 1970s and into the early 1990s (Kagarise Sherman and Morton 1993, pp. 186–198), this factor is likely either a primary driver, or at least a significant contributing factor in the declines that have been observed. Climate models predict increasing drought intensity and changes to the hydroperiod based on reduced snowpack, along with greater climate variability in the future (PRBO 2011, pp. 18–25). These changes will likely exacerbate stress to the habitat specialist Yosemite toad through a pronounced impact on its ephemeral aquatic habitat, and also through an increase in the frequency of freezing and drying events that kill Yosemite toad eggs and tadpoles. These changes and the resultant impacts likely will effectively reduce breeding success of remnant populations already at low abundance and still in decline. If an interaction such as winter stress and disease (Carey 1993, pp. 355–362) is the underlying mechanism for Yosemite toad declines, then the enhanced influence of climate change as a stressor may tip the balance further towards higher incidence and increased virulence of disease, which would also lead to greater population declines and extirpations.

### **Determination for Yosemite Toad**

Section 4 of the Act (16 U.S.C. 1533), and its implementing regulations at 50 CFR part 424, set forth the procedures for adding species to the Federal Lists of Endangered and Threatened Wildlife and Plants. Under section 4(a)(1) of the Act, we may list a species based on (A) The present or threatened destruction, modification, or

curtailment of its habitat or range; (B) Overutilization for commercial, recreational, scientific, or educational purposes; (C) Disease or predation; (D) The inadequacy of existing regulatory mechanisms; or (E) Other natural or manmade factors affecting its continued existence. Listing actions may be warranted based on any of the above threat factors, singly or in combination.

We have carefully assessed the best scientific and commercial information available regarding the past, present, and future threats to the Yosemite toad. The Yosemite toad is the most narrowly distributed Sierra Nevada endemic, pond-breeding amphibian (Shaffer *et al.* 2000, p. 246). Although it apparently still persists throughout a large portion of its historical range, it has been reduced to an estimated 13 percent of historical watersheds. (The proposed rule indicated that the toad was reduced to an estimated 12 percent of its range, peer review corrected this number to 13 percent (Brown 2013, unpaginated). In addition, while the best available data do not provide information on whether populations are currently stable, or whether there is a persistent decline, remnant populations are predominantly small.

Yosemite toad populations are subject to threats from habitat degradation associated with land uses that negatively influence meadow hydrology, fostering meadow dewatering, and conifer and other invasive plant encroachment. These activities include the legacy effects of historic grazing activities, the fire management regime of the past century, historic timber management activities, and associated road construction. The impacts from these threats are cumulatively of moderate magnitude, and their legacy

impacts on meadow habitats act as a constraint upon extant populations now and are expected to hinder persistence and recovery into the future. Diseases are threats of conservation concern that have likely also had an effect on populations leading to historical population decline, and these threats are operating currently and will continue to do so into the future, likely with impacts of moderate-magnitude effects on Yosemite toad populations.

The individual, interactive, and cumulative effects of these various risk factors have acted to reduce the geographic extent and abundance of this species throughout its habitat in the Sierra Nevada. The combined effect of these stressors acting upon small remnant populations of Yosemite toads is of significant conservation concern. The Yosemite toad has a life history and ecology that make it sensitive to drought and anticipated weather extremes associated with climate change. Climate change is expected to become increasingly significant to the Yosemite toad and its habitat in the future throughout its range. Therefore, climate change represents a threat that has a high magnitude of impact as an indirect stressor via habitat loss and degradation, and as a direct stressor via enhanced risk of climate extremes to all life stages of Yosemite toads.

The Act defines an endangered species as any species that is “in danger of extinction throughout all or a significant portion of its range” and a threatened species as any species “that is likely to become endangered throughout all or a significant portion of its range within the foreseeable future.” We find that the Yosemite toad is likely to become endangered throughout all or a significant portion of its range within the

foreseeable future, based on the immediacy, severity, and scope of the threats described above. These include habitat loss associated with degradation of meadow hydrology following stream incision consequent to the cumulative effects of historic land management activities, notably livestock grazing, and also the anticipated hydrologic effects upon habitat from climate change under listing Factor A. Additionally, we find that disease under listing Factor C was likely a contributor to the recent historic decline of the Yosemite toad, and may remain an important factor limiting recruitment in remnant populations. We also find that the Yosemite toad is likely to become endangered through the direct effects of climate change impacting small remnant populations under Factor E, likely compounded with the cumulative effect of other threat factors (such as disease).

We have carefully assessed the best scientific and commercial information available regarding the past, present, and future threats to the species, and have determined that the Yosemite toad meets the definition of threatened under the Act, rather than endangered. This determination is because the impacts from the threats are occurring now at high and moderate magnitudes, but are all likely to become of high magnitude in the foreseeable future across the species' entire range, making the species likely to become in danger of extinction. While population decline has been widespread, the rate of decline is not so severe to indicate extinction is imminent, but this rate could increase as stressors such as climate change impact small remnant populations. Further, the geographic extent of the species remains rather widespread throughout its historic range, conferring some measure of ecological and geographic redundancy. Therefore, on

the basis of the best available scientific and commercial information, we finalize listing the Yosemite toad as threatened in accordance with sections 3(20) and 4(a)(1) of the Act.

The term "threatened species" means any species (or subspecies or, for vertebrates, distinct population segments) that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range. The Act does not define the term "foreseeable future" but it likely describes the extent to which the Service could reasonably rely on predictions about the future in making determinations about the future conservation status of the species. In considering the foreseeable future as it relates to the status of the Yosemite toad, we considered the historical data to identify any relevant existing trends that might allow for reliable prediction of the future (in the form of extrapolating the trends). We also considered how current stressors are affecting the species and whether we could reliably predict any future trends in those stressors that might affect the species recognizing that our ability to make reliable predictions for the future is limited by the quantity and quality of available data. Thus the foreseeable future includes the species' response to these stressors and any trends.

Under the Act and our implementing regulations, a species may warrant listing if it is endangered or threatened throughout all or a significant portion of its range. The Yosemite toad is highly restricted in its range, and the threats occur throughout its range. Therefore, we assessed the status of the species throughout its entire range. The threats to the survival of the species occur throughout the species' range and are not restricted to

any particular significant portion of that range, nor are they concentrated in a specific portion of the range. Accordingly, our assessment and final determination applies to the species throughout its entire range.

### **Summary of Comments**

In the proposed rule published on April 25, 2013 (78 FR 24472), we requested that all interested parties submit written comments on the proposal by June 24, 2013. Given the large number of requests that we received to extend the public comment period, we reopened the comment period on July 19, 2013 (78 FR 43122), requesting written comments on the proposal by November 18, 2013, and again reopened the comment period on January 10, 2014 (79 FR 1805), with the close of comment period on March 11, 2014. We also contacted appropriate Federal and State agencies, scientific experts and organizations, and other interested parties and invited them to comment on the proposal. Newspaper notices inviting general public comment were published in the Sacramento Bee and Bakersfield Californian. We received multiple requests for a public hearing. We held two public hearings on January 30, 2014, in Sacramento, California. We also held two public informational meetings, one in Bridgeport, California, on January 8, 2014, and the other in Fresno, California, on January 13, 2014. We also participated in several public forums, one sponsored by Congressman McClintock and two sponsored by Congressman LaMalfa. All substantive information provided during comment periods has either been incorporated directly into this final determination or addressed below.



### *Peer Reviewer Comments*

In accordance with our peer review policy published on July 1, 1994 (59 FR 34270), we solicited expert opinion from five knowledgeable individuals with scientific expertise that included familiarity with the Sierra Nevada yellow-legged frog, the northern DPS of the mountain yellow-legged frog, the Yosemite toad, and the habitat and biological needs of, and threats to each species. We received responses from four of the peer reviewers.

We reviewed all comments received from the peer reviewers for substantive issues and new information regarding the listing of the Sierra Nevada yellow-legged frog, the northern DPS of the mountain yellow-legged frog, and the Yosemite toad. The peer reviewers generally concurred with our methods and conclusions and provided additional information, clarifications, and suggestions to improve the final rule. However, one of the four peer reviewers suggested the rationale for listing Yosemite toad was poorly supported. Peer reviewer comments are addressed in the following summary and incorporated into the final rule.

(1) *Comment:* Two peer reviewers recommended that we refer to *Rana muscosa* as the southern mountain yellow-legged frog in order to reduce reader confusion in the final rule.

*Our Response:* We have clarified the common names we are using in this final rule for each yellow-legged frog species (see **Background** and **Taxonomy** sections in this final rule). While Crother *et al.* (2008, p. 11) accepted the common name of southern mountain yellow-legged frog for *Rana muscosa*, the use of this common name may create additional confusion as the reader may interpret the name to imply the yellow-legged frogs in southern California that are already listed as the southern DPS, rather than the *R. muscosa* in the Sierra Nevada. Therefore, we continue to refer to the northern DPS of *Rana muscosa* as the northern DPS of the mountain yellow-legged frog, as we did in the proposed rule, to minimize confusion for the public.

(2) *Comment:* Two peer reviewers suggested that we utilize a rangewide analysis for listing *Rana muscosa* and thereby combine the northern and southern DPSs of the mountain yellow-legged frog into one listed entity. Clarifying discussions with one peer reviewer suggested that we not complete a rangewide analysis, but rather keep the DPSs separate (Knapp, pers. comm.).

*Our Response:* Given the geographic isolation, different habitat requirements, differences in threats, and different management needs between *Rana muscosa* in the Sierra Nevada compared with southern California, we have decided to retain the DPS analysis in the proposed rule and to maintain the northern and southern DPSs of mountain yellow-legged frog as separate listed entities. Within the Sierra Nevada, *R. muscosa* is predominantly found within high-elevation lake habitats that freeze during the winter months, while in southern California, *Rana muscosa* populations occupy stream habitats

that are not typically subject to winter freezing. The differences in the habitats utilized by the northern and southern DPSs of the mountain yellow-legged frog and the differences in the threats to each population segment indicate that management actions needed to recover the northern California and southern California populations will also be different and are most expediently addressed separately by DPS (see **Distinct Vertebrate Population Segment Analysis** in this final rule).

The factors that are threats to the species also differ between the two DPSs. We have identified fish stocking and presence of fish as a threat for both the northern and southern DPSs. However, the other threats we identified for the northern DPS are primarily habitat degradation, disease, and climate change, whereas the main threats for the southern DPS consist of recreational activities, roads, and wildfire. While there is some overlap in the threats identified for the two DPSs, the threats that are important to the species status vary substantially between the Sierra Nevada and southern California.

The differences between the northern and southern DPSs of the mountain yellow-legged frog in both habitat use and the factors affecting the species results in differences in the actions and activities that would be needed to conserve the species in each of the two DPSs. Conservation planning, including identifying actions and setting priorities for recovery, will be more effective and better suited to meet the species' needs if two separate DPSs are retained.

(3) *Comment:* One peer reviewer indicated that the frogs within the Spanish and Bean Creek areas of Plumas County (low-elevation areas within the northern portion of the Sierra Nevada) in which Wengert (2008) conducted telemetry studies of frog movement distances, may actually be foothill yellow-legged frog (*Rana boylei*) rather than Sierra Nevada yellow-legged frogs (*Rana sierrae*) (see Habitat and Life History section in **Background** for the mountain yellow-legged frogs of this final rule).

*Our Response:* We acknowledge and understand some of the challenges in correctly identifying the species in areas where the ranges of Sierra Nevada and foothill yellow-legged frogs overlap. Recent genetic analysis of samples collected from frogs in Spanish and Bean Creeks has identified the frogs occurring in Bean Creek as both Sierra Nevada and foothill yellow-legged frogs (Lind *et al.* 2011a, pp. 281–282), while Spanish Creek frogs were identified as foothill yellow-legged frog (Poorten *et al.* 2013, p. 4). However, given the small sample size, Poorten *et al.* (2013, p. 4) suggested that followup investigation was needed to determine whether Sierra Nevada yellow-legged frogs also occur in Spanish Creek.

While it is not clear whether Wengert (2008) studied Sierra Nevada or foothill yellow-legged frogs, given the stream-based ecological setting of the study, we expect that the movement distances recorded are applicable to the Sierra Nevada yellow-legged frog within a stream-based system, as the ecology is comparable between the two sister taxa in regard to stream systems. Additionally, a study conducted by Fellers *et al.* (2013, p. 159) documented Sierra Nevada yellow-legged frog movement distances up to 1,032 m

in a 29-day period, suggesting the season-long movement distance documented by Wengert (2008, p. 20) is applicable.

(4) *Comment:* One peer reviewer provided comment that our proposed rule did not include more-recent literature on the effects of airborne contaminants on the mountain yellow legged frog, including Bradford *et al.* 2011, which measured contaminant concentrations at multiple sites in the southern Sierra Nevada and compared their distribution with population declines of mountain yellow-legged frogs, finding no association between the two. The peer reviewer further recommended that we state that frogs are sensitive to contaminants, but measured contaminant concentrations in multiple media indicate very low exposures to contaminants from upwind sources.

*Our Response:* In our proposed rule, we included a discussion of environmental factors that affect the mountain yellow-legged frog complex, including contaminants. Based on our analysis in the proposed rule, we did not identify this environmental factor as a threat to the species. Upon our review of additional literature, including a study focused specifically on the mountain yellow-legged frog complex, our initial discussion remains valid, which indicated that the potential threat posed by contaminants is not a factor in the listing of this species. We refer to the proposed rule for the discussion of the effects of contaminants on the mountain yellow-legged frog.

(5) *Comment:* One peer reviewer suggested that recent genetic studies (Shaffer *et al.* 2000, Stevens 2001, and Goebel *et al.* 2009) do not support our conclusion that Yosemite toad is a valid species.

*Our Response:* When conducting our review of the Yosemite toad as a listable entity under the Act, we incorporated the results of the studies mentioned by the peer reviewer. In addition to the previously included literature on the genetics of Yosemite toad, we have included in this final rule results from Switzer *et al.* (2009), which provide genetic data supporting the Yosemite toad as a valid species. While we acknowledge that the evolutionary history of the Yosemite toad is complicated and not fully understood, given our conclusions after reviewing the taxonomy of the species, and given that the scientific community as a whole continues to recognize the Yosemite toad as a valid species, we continue to recognize Yosemite toad as a valid species (for further discussion, see **Taxonomy** section above).

(6) *Comment:* One peer reviewer provided information regarding the number of localities of Yosemite toad within two National Parks, and suggested that, had we included these locations, the analysis may have had a different outcome.

*Our Response:* When we conducted our analysis for the proposed rule to determine whether the Yosemite toad warrants listing under the Act, we utilized the best available scientific and commercial information. Part of that information included the geospatial data for Yosemite toad locations within both Yosemite and Sequoia National

Parks. These data were subsequently used for the proposed critical habitat designation. While we did have (and used) the information on Yosemite toad locations within the National Parks in our analysis, we did not cite to this information into the text of the proposed rule. This was updated with the data included in Berlow *et al.* (2013), as well as information received from Sequoia National Park staff. Regardless, we utilized the geospatial data in the proposed rule, determining that the information suggests that the Yosemite toad has disappeared from approximately 47–69 percent of formerly occupied sites (Berlow *et al.* 2013, p. 2). In addition, at many of the remaining sites, Yosemite toads exist in very low numbers, indicating that many remaining populations are vulnerable to extirpation. Our use of the data from both National Forests and National Parks led us to our proposed status determination, which is affirmed here.

(7) *Comment:* One peer reviewer stated that there is scant evidence available to argue that there has been a decline in abundance of the Yosemite toad and that the difficulty in accurately quantifying toad abundance, coupled with the fact that the proposed rule did not include locality data from the National Parks, has weakened the argument for our determination.

*Our Response:* While we agree that no studies have documented a rangewide decline in population abundances in Yosemite toads, and we do not have sufficient data to conduct a robust trend analysis or detect negative population growth rates, we relied on published literature for our determination. At a minimum, the published literature provides anecdotally documented declines in numbers of individual Yosemite toads at the

respective study sites. The best available information shows that the Yosemite toad populations have declined, and that the remnant populations comprise low numbers of individual adult toads. For our analysis, we did utilize the data on toad locations in the National Parks (see our response to comment 6) and included it as part of our analysis on the estimated loss of historically occupied sites (47–69 percent of formerly occupied sites (Berlow *et al.* 2013, p. 2)). We mainly focused our analysis on the potential drivers of population stability and identified the predominate threats to the species as the continuing effects of degradation of meadow hydrology associated with historical land management practices and the effects of climate change and anthropogenic stressors acting on the small remnant populations. (For complete discussion see **Summary of Factors Affecting the Species** section above.)

(8) *Comment:* One peer reviewer stated that there are scientific uncertainties regarding the long-term population trends and threats to Yosemite toad and that these uncertainties should be explicitly described.

*Our response:* As required by the Act, we based our proposed rule and this final rule on the best available scientific and commercial data. While there are some uncertainties in the information, we clearly articulated these uncertainties when conducting our analysis for the rule. (See Population Estimate and Status and Meadow Habitat Loss and Degradation sections for examples.)

*Federal Agency Comments*



(9) *Comment:* The Forest Service suggested that the rule does not represent the best available scientific and commercial information in proposing a determination.

*Our Response:* In conducting our analysis, we rely on the best available scientific and commercial information, as required by the Act. On occasion, we are not aware of certain information that is available at the time we issue a proposed rule or new information becomes available around the time of publication, which is part of the reason we request public comment, as well as peer review. That portion of the process helps to inform our final decision by soliciting input and seeking additional available information. As a result of this process, we have received new scientific and commercial information that we have reviewed and incorporated into this final rule.

(10) *Comment:* The USFS noted that the proposed rule did not identify mining activities as a threat to the mountain yellow-legged frog.

*Our Response:* We acknowledge that there is some overlap between current mining activities and areas occupied by the mountain yellow-legged frogs, particularly in the northern part of the range; however, we do not have information to assess the impact that mining has on the species in those areas where mining occurs, and how it acts as either an historical or current threat to the species. Within designated wilderness, new mining claims have been prohibited since January 1, 1984. Additionally, while suction dredge mining may have the potential to alter microhabitat uses by the species, the

current moratorium on this practice removes this potential threat. However, we acknowledge that this situation may change in the future.

(11) *Comment:* The USFS suggested that the uncertainties we presented under Factor D as it relates to their Forest Plan revision process and protections for mountain yellow-legged frog are not applicable and that the protections under the SNFPA will continue as a result of consultation with the Service.

*Our Response:* We did not identify Factor D as a threat to the mountain yellow-legged frog, and we incorporated an analysis of the protection that the current Forest Plans offer the species. While there is some uncertainty as to whether these protections will remain in the revised Forest Plans, the USFS is not required to consult with the Service on the Sierra Nevada yellow-legged frog and northern DPS of the mountain yellow-legged frog in the absence of the protections afforded under the Act. As such, we must evaluate the adequacy of existing regulatory mechanisms from the baseline of the species not being federally listed under the Act.

(12) *Comment:* The USFS suggested the final rule include a discussion of the impacts of bullfrog predation on the mountain yellow-legged frog.

*Our Response:* We have limited information on the presence of bullfrogs in the Sierra Nevada, but we have included a section on the potential threat of American

bullfrogs where they are known to occur in the Lake Tahoe Basin (see discussion under Factor C for mountain yellow-legged frogs).

(13) *Comment:* The USFS and several other commenters suggested that the information presented as it relates to the impacts of grazing on Yosemite toad was inaccurate. Specifically, they suggested that we did not include the results of peer-reviewed journal articles in our analysis of the impacts posed by livestock grazing.

*Our Response:* At the time of the proposed rule, we were aware of the peer-reviewed literature related to the impacts of livestock grazing on Yosemite toad, and inadvertently omitted the literature from the rule. We have reviewed and included the relevant articles in this final rule. Additionally, while we did not incorporate all of the specifics of the journal articles, we did incorporate the results of a 5-year study that investigated the impacts of cattle grazing on Yosemite toad in our analysis, as they were presented in Allen Diaz *et al.* 2010, and subsequently in the Lind *et al.* (2011b, addendum).

(14) *Comment:* The USFS and several other commenters suggested that our reliance on a single non-peer-reviewed study to assess the impacts of cattle grazing on Yosemite toads, through direct mortality or the modification of their habitat, was inappropriate. Additionally, they suggested we discounted the peer-reviewed published journal articles related to the impacts of cattle grazing on Yosemite toad.

*Our Response:* In conducting our analysis, we rely on the best available scientific and commercial information, as required by the Act. This information does not need to be specifically published in a scientific journal. The Martin (2008) study that is being referred to by the commenters is a doctoral dissertation that was, in fact, reviewed prior to release. We relied on the information presented by Martin in assessing the potential for direct mortality of Yosemite toad that is attributed to livestock. We also relied on Martin for the potential impacts of livestock grazing on overwintering and upland areas utilized by Yosemite toad, as the peer-reviewed publications that the commenters referred to were based on a study that only assessed grazing effects on breeding. As such, the best available scientific and commercial information includes Martin (2008). In our proposed rule, we evaluated the information that ran contrary to Martin (2008), and we have subsequently incorporated the information presented in the peer-reviewed journal articles in this final rule. Please also see response to comment #13.

(15) *Comment:* The USFS commented that chytrid fungus, fish stocking, and climate change pose the greatest threats to the mountain yellow-legged frogs, and that threats from authorized management activities are insignificant threats to the species.

*Our Response:* We have concluded in this final rule that, in general, authorized activities on public lands managed by the USFS and the NPS are not significant threats to the mountain yellow-legged frogs, but we also recognize that there may be limited site-specific conditions where authorized activities could have population-level effects,

especially where populations are small or habitat areas are limited (see **Summary of Factors Affecting the Species** in this final rule).

(16) *Comment:* The USFS noted that recent publications indicate that livestock grazing that meets current USFS standards and guidelines is less of a threat to the Yosemite toad than was described in the proposed rule.

*Our Response:* We have revised our discussion of grazing in this final rule to clarify the conditions under which we consider current grazing activities to pose habitat-related threats to the Yosemite toad (see Summary of Changes and Factor A discussion for the Yosemite toad).

#### *Comments from States*

(17) *Comment:* The California Department of Fish and Wildlife (CDFW) originally commented that the threats presented in the proposed rule suggested that a determination of threatened status would be more appropriate than endangered for the Sierra Nevada yellow-legged frog. However, CDFW reconsidered this suggestion after discussions with Service staff and submitted a followup comment letter that agrees with the Service determination and supports listing the Sierra Nevada yellow-legged frog as endangered.

*Our Response:* We find that an endangered status for the Sierra Nevada yellow-legged frog is an appropriate determination and appreciate CDFW's reconsideration of their initial comments.

(18) *Comment:* CDFW commented that they remain concerned that listing the species as endangered could hinder timely implementation of the Department's recovery and restoration efforts for the species pursuant to its State-listing under CESA. CDFW notes that they have a responsibility to continue activities and expand efforts that will contribute to the recovery of the Sierra Nevada yellow-legged frog and hope that such efforts can be fostered through the 1991 *Cooperative Agreement between the California Department of Fish and Game and the U.S. Fish and Wildlife Service*. They also comment that, in his June 13, 2012, memo to the Service's Regional Directors, the Director of the Fish and Wildlife Service acknowledged the Federal-State collaborative nature of conservation activities for listed species.

*Our Response:* We note that, for research activities that aid in the recovery of the species, and that may result in take, a permit issued under section 10a(1)A of the Act is the appropriate mechanism. However, our regulations at 50 CFR 17.21 state that any qualified employee or agent who is designated by CDFW for such purposes, may, when acting in the course of his official duties, take endangered wildlife species covered by a Cooperative Agreement (developed pursuant to Section 6 of the Act) between the Service and the State provided such take is not reasonably anticipated to result in: (1) the death or permanent disabling of the specimen; (2) the removal of the specimen from the State of

California; (3) the introduction of the specimen or any of its progeny into an area beyond the historical range of the species; or (4) the holding of the specimen in captivity for a period of more than 45 days. Take that does not meet these four conditions would require a section 10(a)(1)(A) permit. We acknowledge and appreciate the important role that CDFW will play in the recovery of the Sierra Nevada yellow-legged frog, and look forward to continuing collaborative conservation actions with CDFW for this and other listed species in California.

(19) *Comment:* CDFW agreed that we should retain the northern DPS and the southern DPS designations for the mountain yellow-legged frog (*Rana muscosa*). They provided updates to our discussion of take related to State-listing of the mountain yellow-legged frog complex.

*Our Response:* We appreciate the support, and we have retained the two DPSs in the final determination (see **Distinct Vertebrate Population Segment Analysis**). We have also revised our discussion of CESA to provide the updated information on take related to State-listing of the mountain yellow-legged frog complex (see Factor D for mountain yellow-legged frog).

(20) *Comment:* CDFW provided comments on our discussion of the following threats to the mountain yellow-legged frog complex: Recreational activities, past trout stocking versus continued trout stocking, and pesticide detection in the Sierra Nevada. They commented that the evidence presented in the Recreation section did not support

the conclusion, urging us to readdress the section and remove claims unsupported by appropriate citations, and noted that recreation effects to the environment were supported, but no evidence indicates that such activities affect the frog populations. In the Recreation section, they also noted several errors and inaccuracies in citing other authors. CDFW provided extensive comments on our discussion of dams and water diversions, commenting that they were of the opinion that dams and diversion posed a threat of low significance to the continued existence of the mountain yellow-legged frogs and suggesting that the section required significant amendments to accurately capture the degree of potential impacts. They noted that most dams were constructed below the range of extant frog populations, and that some information was misapplied from research on lower-elevation amphibian species, such as the foothill yellow-legged frog, which resulted in overstatement of the potential impact of dams and water diversions on the mountain yellow-legged frog complex. They provided numerous smaller specific comments on text within the section.

*Our Response:* We thank the CDFW for the additional information provided to strengthen our analysis. We have addressed these comments through changes to the Fish Stocking, Recreation, and Dams and Water Diversions sections for the Sierra Nevada and mountain yellow-legged frogs in this final rule. We re-checked references and revised the sections noted to state more clearly the potential effects of these activities, to rely on appropriate citations, and to refine our conclusions in agreement with CDFW's comments. Please see Factor A in **Summary of Factors Affecting the Species** for updated information.



## *Public Comments*

(21) *Comment:* Several commenters suggested that the Service does not have the authority or jurisdiction to designate the Sierra Nevada yellow-legged frog and the northern DPS of the mountain yellow-legged frog as endangered nor the Yosemite toad as threatened.

*Our Response:* The authority for the Service to issue this rulemaking comes from the Endangered Species Act of 1973 (16 U.S.C. 1531 *et seq.*), as amended, through the 108<sup>th</sup> Congress. The Service is designated as the lead Federal agency for implementing the Act for terrestrial and freshwater species. Authority to implement the Act does not require Federal jurisdiction or land ownership

(22) *Comment:* Multiple commenters indicated that existing Federal and State legislation and regulations, such as the Wilderness Act, CESA, and CDFW regulations, provide sufficient protection for these amphibians, and thereby eliminate the need for listing the species.

*Our Response:* We agree that existing Federal and State legislation and regulations, such as the Wilderness Act, CESA, and CDFW regulations provide some protection for the Sierra Nevada yellow-legged frog, the northern DPS of the mountain yellow-legged frog, and the Yosemite toad. However, while existing legislation and

regulations provide some level of protection for the Sierra Nevada yellow-legged frog, the northern DPS of the mountain yellow-legged frog, and the Yosemite toad, they do not require that Federal agencies ensure that actions that they fund, authorize, or carry out will not likely jeopardize the species' continued existence (for further information see discussions under Factor D). Therefore, we have determined that the Sierra Nevada yellow-legged frog and the northern DPS of the mountain yellow-legged frog are endangered and that the Yosemite toad is threatened under the Act.

(23) *Comment:* Several commenters suggest that it is necessary for the Service to conduct an analysis of the impacts that listing a species may have on local economies prior to issuance of a final rule.

*Our Response:* Under the Act, the Service is not required to conduct an analysis regarding the economic impact of listing endangered or threatened species. However, the Act does require that the Service consider the economic impacts of a designation of critical habitat. A draft of this analysis is available to the public on <http://www.regulations.gov> (79 FR 1805).

(24) *Comment:* Several commenters suggested that the decline of the Sierra Nevada yellow-legged frog, northern DPS of the mountain yellow-legged frog, and the Yosemite toad is a natural evolutionary process, and that the presence of environmental stressors is a normal driver of evolution and/or extinction.

*Our Response:* Under the Act, we are required to use the best available scientific and commercial information to assess the factors affecting a species in order to make a status determination. The Act requires the Service to consider all threats and impacts that may be responsible for declines as potential listing factors. The evidence presented suggests that the threats to the species are both natural and manmade (see Factor E—Other Natural or Manmade Factors Affecting the Species), but that they are primarily the result of anthropogenic influences (see **Summary of Factors Affecting the Species** in this final rule). Thus, the threats associated with the declines of these species are not part of a natural evolutionary process.

(25) *Comment:* Several commenters were concerned about the effects of listing on mining and associated activities conducted under the General Mining Law of 1872. They suggested that the listing of these species will remove 5 million acres from mining and other productive uses of the land. One commenter was concerned that there would be no assurances that development of a mining claim will result in the ability to mine it.

*Our Response:* In the proposed rule, we identified unauthorized discharge of chemicals or fill material into any water upon which the Sierra Nevada yellow-legged frog, the northern DPS of the mountain yellow-legged frog, and the Yosemite toad are known to occur as a potential threat to these species. On National Forests outside of designated wilderness, new mining may occur pursuant to the Mining Law of 1872 (30 U.S.C. 21 *et seq.*), which was enacted to promote exploration and development of domestic mineral resources, as well as the settlement of the western United States. It

permits U.S. citizens and businesses to prospect hardrock (locatable) minerals and, if a valuable deposit is found, file a claim giving them the right to use the land for mining activities and sell the minerals extracted, without having to pay the Federal Government any holding fees or royalties (GAO 1989, p. 2). Gold and other minerals are frequently mined as locatable minerals, and, as such, mining is subject to the Mining Law of 1872. However, Federal wilderness areas were closed to new mining claims at the beginning of 1984 (see Factor D under mountain yellow-legged frogs above), thereby precluding the filing of new mining claims in those areas designated as Federal wilderness (a large part of the area in which the species occur). Authorization of mining under the Mining Law of 1872 is a discretionary agency action pursuant to section 7 of the Act. Therefore, Federal agencies with jurisdiction over land where mining occurs will review mining and other actions that they fund, authorize, or carry out to determine if listed species may be affected in accordance with section 7 of the Act.

(26) *Comment:* Numerous commenters suggested that the listing of the Sierra Nevada yellow-legged frog, the northern DPS of the mountain yellow-legged frog, and the Yosemite toad are being misused to restrict or prohibit access for fishing, hiking, camping, and other recreational uses, and implement land use restrictions, management requirements, and personal liabilities on the public that are not prudent, clearly defined, or necessary.

*Our Response:* The listing of the Sierra Nevada yellow-legged frog, the northern DPS of the mountain yellow-legged frog, and the Yosemite toad does not prevent access

to any land, whether private, tribal, State, or Federal. The listing of a species does not affect land ownership or establish a refuge, wilderness, reserve, or other conservation area. A listing does not allow the government or public to access private lands without the permission of the landowner. It does not require implementation of restoration, recovery, or enhancement measures by non-Federal landowners. Federal agencies will review actions that they fund, authorize, or carry out to determine if any of these three amphibians, and other listed species as appropriate, may be affected by the Federal action. The Federal agency will consult with the Service, in accordance with Section 7 of the Act (see also response to comment 25).

*(27) Comment:* Several commenters suggested that listing the Sierra Nevada yellow-legged frog and the northern DPS of the mountain yellow-legged frog under the Act is not necessary given that a majority of the range of these species is within wilderness areas afforded protection under the Wilderness Act and by the protections afforded under CESA.

*Our Response:* We agree that existing Federal and State legislation and regulations, such as the Wilderness Act and CESA, provide some protection for the Sierra Nevada mountain yellow-legged frog, the northern DPS of the mountain yellow-legged frog, and the Yosemite toad. However, we identified the main threats to the two frog species as habitat degradation and fragmentation, predation and disease, climate change, and the interactions of these stressors on small populations. Neither the Wilderness Act nor the State's listing status under CESA ameliorates these threats to

levels that would preclude the need to list the species under the Act. (See discussion under **Factor D**).

(28) *Comment:* One commenter suggested that habitat and range of the mountain yellow-legged frog is not threatened with destruction or modification based on a large portion being located in wilderness, and the proposed rule stating “physical habitat destruction does not appear to be the primary factor associated with the decline of the mountain yellow-legged frogs.”

*Our Response:* While we agree that the loss, destruction, or conversion of physical habitat is not a primary factor in the decline of the mountain yellow-legged frogs, we discuss both the biological modification of habitat due to changes in predator communities, prey communities, and in nutrient levels, and due to the habitat fragmentation associated with the presence of introduced fish. Although the presence of introduced fish does not result in conversion or loss of the physical attributes of habitat (for example, removal or filling of lakes, ponds, etc.), fish presence does effectively preclude the use of the habitat by the mountain yellow-legged frog (see our discussion under Factor A). While a large portion of the range of the mountain yellow-legged frog is within federally designated wilderness, or on National Parks, we identified the main threats to the species as habitat degradation and fragmentation, predation and disease, climate change, and the interactions of these stressors on small populations. Neither the Wilderness Act nor the protections afforded within National Parks ameliorates these

threats to levels that would preclude the need to list the species under the Act (see discussion under Factor D).

(29) *Comment:* One commenter stated that we failed to consider the effectiveness of restoration activities being conducted by CDFW as part of their High Mountain Lakes Project and plans for Yosemite and Sequoia and Kings National Parks that are intended to implement restoration actions.

*Our Response:* We are aware of the activities, including the High Mountain Lakes Project (see Factor A discussions above in this final rule), being conducted by CDFW, USFS, NPS, and researchers aimed at restoring habitat for the mountain yellow-legged frog. While efforts of interested parties have resulted in the restoration of habitat for these species, the restored habitat represents a small portion of the range of the species, and has occurred only in localized areas. As such, these activities, while beneficial and important for the recovery of the species, do not significantly counter the threats of introduced predators, disease, or climate change. Additionally, we are aware of planning efforts by Yosemite and Sequoia and Kings National Parks, partially implemented, and we are aware that these restoration plans have not been finalized.

(30) *Comment:* One commenter provided information suggesting livestock are responsible for the transportation of Bd in the environment.

*Our Response:* While livestock may provide a vector for the transmission of amphibian disease within the Sierra Nevada, there are numerous other mechanisms of transport, including wildlife, as well as anthropogenic vectors. Since the importance of differing disease vectors related to Bd is poorly understood, we did not include a discussion of disease transport associated with livestock grazing in this rule (see Factor C for discussion of disease).

(31) *Comment:* One commenter provided information to suggest that activities associated with illicit cultivation of marijuana on National Forest System lands should be identified as a potential threat to the mountain yellow-legged frog.

*Our Response:* We agree that aspects associated with illegal cultivation of marijuana on National Forest System lands may pose a risk to the mountain yellow-legged frogs, such as dewatering of habitats and contamination from pesticides and fertilizers. There is potential overlap with this illegal activity and areas occupied by mountain yellow-legged frogs; however, not enough information is available at this point to assess the impact that illegal cultivation of marijuana has on the species.

(32) *Comment:* Several commenters suggest that there is insufficient evidence to make a listing determination for the mountain yellow-legged frog in accordance with the Act.



*Our Response:* As we have presented in both the proposed rule and this final rule, a substantial compilation of scientific and commercial information is available to support listing both the Sierra Nevada yellow-legged frog and the northern DPS of the mountain yellow-legged frog under the Act. We have presented evidence that there has been a curtailment in range and numbers attributed to habitat degradation and fragmentation under Factor A, predation and disease under Factor C, and climate change and the interaction of these various stressors cumulatively impacting small remnant populations under Factor E (see **Determination for the Sierra Nevada Yellow-legged Frog** and **Determination for the Northern DPS of the Mountain Yellow-legged Frog** sections above for a synopsis and see the **Summary of Factors Affecting the Species** for a detailed analysis).

(33) *Comment:* Numerous commenters purported that the greatest threat to the mountain yellow-legged frog is Bd, and since listing the species will not alleviate the threat, the species should not be listed. Additionally, it was suggested that these species should be reared in captivity until the threat of Bd is resolved.

*Our Response:* We agree that Bd is one of the primary contributing factors in the current decline of these species; however, it is not the only factor responsible for their decline or the only one forming the basis of our determination. All Factors are considered when making a listing determination (see the **Summary of Factors Affecting the Species** for a detailed discussion). We have also identified habitat fragmentation and predation attributed to the introduction of fish and climate change as threats to the

species. We are required to evaluate all the threats affecting a species, including disease under Factor C.

With respect to the prospect of captive breeding, we acknowledge that this activity is one of the suite of tools that can be utilized for the conservation of the species. Captive breeding is currently being conducted for the southern DPS of the mountain yellow-legged frog, and we are currently working with various facilities to explore this option. Additionally, when a species is listed as either endangered or threatened, the Act provides many tools to advance the conservation of listed species; available tools including recovery planning under section 4 of the Act, interagency cooperation and consultation under section 7 of the Act, and grants to the States under section 6 of the Act. All of these mechanisms assist in the conservation of the species.

(34) *Comment:* Several commenters provided information to suggest that livestock grazing is not detrimental to amphibian species and that the proposed rule did not adequately capture the neutral or beneficial effects of livestock grazing on amphibian species.

*Our Response:* We have revised our discussion of grazing in this final rule to clarify the conditions under which we consider current grazing activities to pose habitat-related threats (see Factor A above). In addition, research with a related ranid frog of western montane environments, (the Columbia spotted frog, *Rana luteiventris*) has indicated that livestock grazing may reduce vegetation levels in riparian and wet meadow

habitat, but does not have short-term effects on the frog populations, although they caution that the length of the study may not capture potential long-term effects (Adams *et al.* 2009, pp. 132, 137). However, George *et al.* (2011, pp. 216, 232) in a review of the effectiveness of management actions on riparian areas, noted that continuous grazing often results in heavy grazing use of riparian areas, even if an area is lightly stocked, because livestock are attracted to the areas from adjacent uplands. They note substantial literature that documents that livestock grazing could damage riparian areas, and the resulting move, beginning in the 1980s, in Federal and State resource agencies to apply conservation practices to protecting and improving riparian habitats (George *et al.* 2011, p. 217). They note that studies provide sufficient evidence that riparian grazing management that maintains or enhances key vegetation attributes will enhance stream channel and riparian soil stability, although variable biotic and abiotic conditions can have site-specific effects on results (George *et al.* 2011, pp. 217–227).

In our proposed rule, we focused on livestock grazing as a potential listing factor, and while there are potentially some current, localized effects to the Sierra Nevada yellow-legged frog, the northern DPS of the mountain yellow-legged frog, and the Yosemite toad, we consider the majority of the impacts associated with livestock grazing are the legacy effects of historically high grazing intensities.

(35) *Comment:* One commenter stated that the discussion of the effects of global climate change in the proposed rule for the Sierra Nevada yellow-legged frog, northern DPS of the mountain yellow-legged frog, and Yosemite toad was not appropriate. The

commenter believed that the Service “pushes” the climate models, both spatially and temporally, beyond what the commenter considered to be reliable, and ignores their uncertainty. In addition, the commenter claims that no credible models can project potential climate change in the Sierra Nevada. The commenter stated the Act is not an appropriate mechanism to regulate global climate change and greenhouse gases. Finally, the commenter suggested if the Service does list the three amphibians, that they be designated as threatened species with a section 4(d) rule that excludes lawful greenhouse gases from the prohibitions of the Act.

*Our Response:* We used the best available scientific and commercial information available as it pertains to climate change. In addition to the peer-reviewed scientific journal articles and reports that were utilized in our analysis and cited in the proposed rule, recently published studies have presented data and conclusions that increase the level of confidence that global climate change is the result of anthropogenic actions (summarized in Blaustein *et al.* 2010 and discussed above). A recent paper (Kadir *et al.* 2013) provides specific information on the effects of climate change in the Sierra Nevada and is discussed above. While the Service is concerned about the effects of global climate change on listed species, wildlife, and their habitats, to date, we have not used the Act to regulate greenhouse gases. We evaluated the suggestion that the three amphibians be listed as threatened species with a section 4(d) rule excluding prohibitions or restrictions on greenhouse gases. However, our determination is that the Sierra Nevada yellow-legged frog and the northern DPS of the mountain yellow-legged frog meet the

definition of endangered, the Yosemite toad meets the definition of threatened, and a section 4(d) rule for greenhouse gases is not appropriate.

(36) *Comment:* One commenter suggested that the discussion of genetics for the mountain yellow-legged frog does not support the taxonomy of the Sierra Nevada yellow-legged frog and the northern DPS of the mountain yellow-legged frog as separate species. The commenter further suggested the text of the rule specifying two major genetic lineages and four groups does not support listing of the frogs as separate genetic groups.

*Our Response:* Vredenburg *et al.* (2007, p. 317) did not rely solely on DNA evidence in the recognition of two distinct species of mountain yellow-legged frog in the Sierra Nevada, but instead used a combination of DNA evidence, morphological information, and acoustic studies. The taxonomy of the mountain yellow-legged frogs as two distinct species in the Sierras has been widely accepted in the scientific community and by species experts. We are not listing a subspecies but rather two separate, recognized species, the Sierra Nevada yellow-legged frog and the northern DPS of the mountain yellow-legged frog.

(37) *Comment:* Several commenters suggested that activities such as timber harvest, road construction, recreation, and livestock grazing are in decline in the Sierras compared with historical levels and should not be included as potential threats to the

Sierra Nevada yellow-legged frog, the northern DPS of the mountain yellow-legged frog, or the Yosemite toad.

*Our Response:* In conducting our analysis of the factors affecting the species, we did include timber harvest, road construction, recreation, and livestock grazing, as potential threats to the species, but acknowledge that the major impact on the species was the result of the legacy effects of historical practices, and that these activities currently pose a lower intensity, localized threat. We have attempted to clarify the distinction in this final rule (see Factor A discussions above).

(38) *Comment:* Numerous commenters stated that listing the mountain yellow-legged frogs and the Yosemite toad would prevent fuels-reduction activities, leading to fires and loss of habitat.

*Our Response:* In this final rule under Factor A for the mountain yellow-legged frogs and Yosemite toad, we address potential habitat changes that may be related to timber harvest activities, including harvests for fuels reduction purposes. We found that most populations of the three species occur at high elevations above areas where timber harvests are likely. At lower elevations, forest standards and guidelines would be expected to limit potential threats to the species in most cases, although limited site-specific situations might result in habitat effects with population consequences. We also found that changed fire regimes have, in some of the same lower elevation areas, led to an increased potential for high-intensity fires, which could alter habitat and, therefore,

pose relatively localized population-level effects to the species. For the Yosemite toad, we found that although ground-disturbance due to timber harvest activities has the potential to have population-level effects at lower elevations, especially where habitat is limited, currently the best available information indicates toads might achieve long-term benefits from activities that reduce encroachment of trees into breeding sites. Therefore, we expect that fuels-reduction activities in lower elevation areas will be generally beneficial to these species.

(39) *Comment:* A number of commenters suggested that, given the results of more-recent studies that were not included in the proposed rule, livestock grazing should be removed as a threat to the Yosemite toad (See also comment 13 from the USFS).

*Our Response:* In our proposed rule, we addressed the potential impacts of grazing on Yosemite toad based on Allen-Diaz *et al.* (2010). The more-recent studies referenced (such as Roche *et al.* 2012a and 2012b, and McIlroy *et al.* 2013) are different publications but are based on the results of the companion studies whose initial report, and subsequent addendum, we referenced as Allen-Diaz *et al.* (2010) and Lind *et al.* (2011b). The study conducted determined that livestock grazing in accordance with the USFS's standards and guidelines does not affect Yosemite toad breeding success. While appropriately managed levels of grazing do not impact breeding success, these grazing standards are not always met. Additionally, the main impact of grazing on Yosemite toad is due to the legacy effects of historical grazing intensities on Yosemite toad habitat. Given the limitations of the study (see discussion under Factor A) and the documentation

that these standards are not always met, livestock grazing may continue to pose a localized threat to the species.

(40) *Comment:* One commenter provided several comments suggesting that livestock grazing is not a threat to Yosemite toad in light of the results of a current study, the documentation of Yosemite toads existing in areas that have been subject to grazing for centuries, and because the population declines cited in our proposed rule occurred in an area not subject to grazing.

*Our Response:* See response to comments 13, 14, and 39. In our proposed rule, we identified the impacts of livestock grazing primarily from an historical context as a potential contributor to meadow degradation. There is a great deal of information, while not specific to Yosemite toad, on the negative impacts of high-intensity grazing regimes on ecosystem dynamics. Grazing under current Forest Service standards does not appear to impact Yosemite toad breeding, however when inappropriate levels of grazing do occur, grazing may still present a localized impact on Yosemite toads via direct mortality or through practices that prevent the hydrologic recovery of historically wet meadow systems. While the documented declines of Yosemite toad have occurred in areas that are not currently subject to livestock grazing, historical grazing occurred throughout the Sierra Nevada. We did not implicate livestock grazing in the decline in population sizes, rather as a potential historical driver in meadow degradation rangewide. We have clarified this distinction in the final rule (see Factor A discussion and **Summary of Factors Affecting the Species** for the Yosemite toad).



(41) *Comment:* One commenter suggested that livestock grazing continues to provide a threat to the Sierra Nevada yellow-legged frog and Yosemite toad and provided information documenting habitat degradation attributed to current livestock grazing and utilization above the standards of the SNFPA.

*Our Response:* As we have presented in the proposed and final rules, the impact of livestock grazing on these species is primarily one of historical significance, with the potential for future localized impacts to the species and/or their habitat. Based on the information provided regarding habitat conditions and potential impacts to habitat, we have maintained our position that current livestock grazing poses a localized impact to the mountain yellow-legged frogs and a prevalent threat with moderate impacts to the Yosemite toad.

(42) *Comment:* One party commented that we have not demonstrated that the Sierra Nevada population of the mountain yellow-legged frog is a DPS. They indicate that we have not shown that the population is significant to the taxon as a whole because we have not shown whether other populations of the species could persist in the high-elevation Sierra Nevada portion of the species' range or discussed how the Sierra Nevada populations are adapted to the area. In addition, they indicate that we failed to show that extirpation of the northern population would result in a significant gap in the range of the species, and we did not show that the populations had markedly different genetics characteristics.

*Our Response:* The commenters correctly noted that, to recognize a population of a species as a DPS, we must establish that the population is (1) discrete from the remainder of the populations to which the species belongs, and (2) if determined to be discrete, it is also found to be significant to the species to which it belongs. However, the commenters incorrectly conclude that the population must meet all three criteria for significance. We find the northern population of the mountain yellow-legged frog to be discrete from the southern population because it is separated from the southern frogs by a 225-km (140-mi) barrier of unsuitable habitat. The primary basis for our finding that the northern population is significant to the species as a whole is that loss of the northern population would mean the loss of the species from a large portion of its range and reduce the species to small isolated occurrences in southern California. The population also meets two additional criteria for significance: (1) Evidence of the persistence of the discrete population segment in an ecological setting unusual or unique for the taxon, and (2) evidence that the discrete population segment differs markedly from the remainder of the species in its genetic characteristics. We have revised the language in our DPS analysis to clarify the basis for the determination (see **Distinct Vertebrate Population Segment Analysis**).

(43) *Comment:* Numerous commenters commented that we were required to complete a NEPA analysis of the proposed listing.

*Our Response:* We have determined that environmental assessments and environmental impact statements, as defined under the authority of the National Environmental Policy Act (NEPA; 42 U.S.C. 4321 *et seq.*), need not be prepared in connection with listing a species as an endangered or threatened species under the Endangered Species Act. We published a notice outlining our reasons for this determination in the **Federal Register** on October 25, 1983 (48 FR 49244) (see **Required Determinations** section of this rule).

(44) *Comment:* One commenter asked that, if we determine that the three amphibian species under consideration are endangered or threatened under the Act, then we enter into a cooperative agreement with the State of California under section 6 of the Act.

*Our Response:* We have been operating under such a cooperative agreement with the California Department of Fish and Game (now Department of Fish and Wildlife (CDFW)) since 1991.

*<http://www.dfg.ca.gov/wildlife/nongame/publications/docs/CDFGCooperativeAgreementWithUSFWS.pdf>*

(45) *Comment:* One commenter stated that if the three amphibians considered are listed as threatened or endangered, then research should continue into the causes of population decline.

*Our Response:* We expect research on these issues to continue into the future. Once the three amphibians are listed as threatened or endangered species under the Act, additional funding for research and other conservation programs for those species will become available through grants established under section 6 of the Act. Such grants are provided to State agencies with which we have established cooperative agreements.

(46) *Comment:* One commenter indicated that because of a County resolution, we must coordinate with the board of supervisors of that County prior to publishing a final rule.

*Our Response:* We provide all interested parties an equal opportunity to submit comments or information prior to publication of a final rule, and we give equal consideration to all such information and comments, regardless of source. Our requirements for “coordination,” however, are established by the Act, by other Federal statutes such as the Administrative Procedure Act, and by executive order.

(47) *Comment:* Several commenters asked for additional time to provide comments. One commenter added that we provided little public outreach.

*Our Response:* As discussed in the first paragraph of the **Summary of Comments and Recommendations** section (above), we provided two additional public comment periods for a total of 240 days (approximately 8 months) of public

comment. We also hosted two public hearings and two public informational meetings at various locations within the range of the species under consideration. We also attended two additional public meetings hosted by Congressmen representing districts within the range of the species. We contacted and sought input from appropriate Federal and State agencies, scientific experts and organizations, and other interested parties. We also published notices in the newspapers with the largest readerships within both the northern and southern portions of the ranges of the species. Additional public comment periods or outreach were not feasible given limitations imposed by available funds and requirements imposed by the Act regarding available time in which to publish a final rule.

(48) *Comment:* One commenter noted that the Act authorizes the Secretary to extend the time available for publication of a final rule by up to 6 months if “there is substantial disagreement regarding the sufficiency or accuracy of the available data.” The commenter stated that such substantial disagreement does exist and so requested that the available time be extended by 6 months. Specifically, the commenter indicated that the available data are not sufficient to support listing after taking into account various Federal and State statutes and programs currently benefiting the three species. Such statutes and programs include the Wilderness Act, the Sierra Nevada Forest Plan, the Clean Water Act, the California Endangered Species Act, and the discontinuation of fish stocking by CDFW in much of the range of the two frogs.

*Our Response:* While we agree that these efforts aid in the conservation of the three amphibians, we do not consider substantial disagreement to exist regarding our

conclusion that the Sierra Nevada yellow-legged frog and the northern DPS of the mountain yellow-legged frog meet the definition of “endangered species” under the Act. We considered the existing Federal and State statutes and programs in our determination. The data documenting population declines and extirpations associated with Bd and the presence of introduced fish are sufficient for the Service to determine that the two species are “in danger of extinction throughout all or a significant portion of [their] range[s].” Data also show that the Yosemite toad is vulnerable to habitat changes and climate change, and thus merits listing as a threatened species, which is defined as “likely to become an endangered species within the foreseeable future within all or a significant portion of its range.”

#### **Available Conservation Measures**

Conservation measures provided to species listed as endangered or threatened under the Act include recognition, recovery actions, requirements for Federal protection, and prohibitions against certain practices. Recognition through listing results in public awareness, and conservation by Federal, State, Tribal, and local agencies, private organizations, and individuals. The Act encourages cooperation with the States and requires that recovery actions be carried out for all listed species. The protection required by Federal agencies and the prohibitions against certain activities are discussed, in part, below.

The primary purpose of the Act is the conservation of endangered and threatened species and the ecosystems upon which they depend. The ultimate goal of such conservation efforts is the recovery of these listed species, so that they no longer need the protective measures of the Act. Subsection 4(f) of the Act requires the Service to develop and implement recovery plans for the conservation of endangered and threatened species. The recovery planning process involves the identification of actions that are necessary to halt or reverse the species' decline by addressing the threats to its survival and recovery. The goal of this process is to restore listed species to a point where they are secure, self-sustaining, and functioning components of their ecosystems.

Recovery planning includes the development of a recovery outline shortly after a species is listed and preparation of a draft and final recovery plan. The recovery outline guides the immediate implementation of urgent recovery actions and describes the process to be used to develop a recovery plan. Revisions of the plan may be done to address continuing or new threats to the species, as new substantive information becomes available. The recovery plan identifies site-specific management actions that set a trigger for review of the five factors that control whether a species remains endangered or may be downlisted or delisted, and methods for monitoring recovery progress. Recovery plans also establish a framework for agencies to coordinate their recovery efforts and provide estimates of the cost of implementing recovery tasks. Recovery teams (composed of species experts, Federal and State agencies, nongovernmental organizations, and stakeholders) are often established to develop recovery plans. When completed, the recovery outline, draft recovery plan, and the final recovery plan will be

available on our website (<http://www.fws.gov/endangered>), or from our Sacramento Fish and Wildlife Office (see **FOR FURTHER INFORMATION CONTACT**).

Implementation of recovery actions generally requires the participation of a broad range of partners, including other Federal agencies, States, Tribal, nongovernmental organizations, businesses, and private landowners. Examples of recovery actions include habitat restoration (e.g., restoration of native vegetation), research, captive propagation and reintroduction, and outreach and education. The recovery of many listed species cannot be accomplished solely on Federal lands because their range may occur primarily or solely on non-Federal lands. To achieve recovery of these species requires cooperative conservation efforts on private, State, and Tribal lands.

Following publication of this final listing rule, funding for recovery actions will be available from a variety of sources, including Federal budgets, State programs, and cost share grants for non-Federal landowners, the academic community, and nongovernmental organizations. In addition, pursuant to section 6 of the Act, the States of California and Nevada would be eligible for Federal funds to implement management actions that promote the protection or recovery of the Sierra Nevada mountain yellow-legged frog, Northern Distinct Population Segment of the mountain yellow-legged frog, and the Yosemite toad. Information on our grant programs that are available to aid species recovery can be found at: <http://www.fws.gov/grants>.



Please let us know if you are interested in participating in recovery efforts for the Sierra Nevada yellow-legged frog, the northern DPS of the mountain yellow-legged frog, or the Yosemite toad. Additionally, we invite you to submit any new information on these species whenever it becomes available and any information you may have for recovery planning purposes (see **FOR FURTHER INFORMATION CONTACT**).

Section 7(a) of the Act requires Federal agencies to evaluate their actions with respect to any species that is listed as an endangered or threatened species and with respect to its critical habitat, if any is designated. Regulations implementing this interagency cooperation provision of the Act are codified at 50 CFR part 402. Section 7(a)(2) of the Act requires Federal agencies to ensure that any action authorized, funded or carried out by such agency is not likely to jeopardize the continued existence of the species or destroy or adversely modify its critical habitat. If a Federal action may affect a listed species or its critical habitat, the responsible Federal agency must enter into consultation with the Service.

Federal agency actions within the species' habitat that may require consultation, as described in the preceding paragraph, include management and any other landscape-altering activities on Federal lands administered by the USFS, NPS, and other Federal agencies as appropriate.

The Act and its implementing regulations set forth a series of general prohibitions and exceptions that apply to all endangered and threatened wildlife. The prohibitions of

section 9(a)(2) of the Act, codified at 50 CFR 17.21 for endangered wildlife, in part, make it illegal for any person subject to the jurisdiction of the United States to take (includes harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect; or to attempt any of these), import, export, ship in interstate commerce in the course of commercial activity, or sell or offer for sale in interstate or foreign commerce any listed species. Under the Lacey Act (18 U.S.C. 42–43; 16 U.S.C. 3371–3378), it is also illegal to possess, sell, deliver, carry, transport, or ship any such wildlife that has been taken illegally. Certain exceptions apply to agents of the Service and State conservation agencies.

We may issue permits to carry out otherwise prohibited activities involving endangered and threatened wildlife species under certain circumstances. Regulations governing permits are codified at 50 CFR 17.22 for endangered species, and at 17.32 for threatened species. With regard to endangered wildlife, a permit must be issued for the following purposes: for scientific purposes, to enhance the propagation or survival of the species, and for incidental take in connection with otherwise lawful activities.

It is our policy, as published in the **Federal Register** on July 1, 1994 (59 FR 34272), to identify to the maximum extent practicable at the time a species is listed, those activities that would or would not constitute a violation of section 9 of the Act. The intent of this policy is to increase public awareness of the effect of a listing on proposed and ongoing activities within the range of listed species. The following activities could potentially result in a violation of section 9 of the Act; this list is not comprehensive:

(1) Unauthorized collecting, handling, possessing, selling, delivering, carrying, or transporting of the species, including import or export across State lines and international boundaries, except for properly documented antique specimens of these taxa at least 100 years old, as defined by section 10(h)(1) of the Act;

(2) Introduction of species that compete with or prey upon the Sierra Nevada yellow-legged frog, the northern DPS of the mountain yellow-legged frog, or the Yosemite toad;

(3) The unauthorized release of biological control agents that attack any life stage of these species;

(4) Unauthorized modification of the mountain meadow habitats or associated upland areas important for the breeding, rearing, and survival of these species; and

(5) Unauthorized discharge of chemicals or fill material into any waters in which the Sierra Nevada yellow-legged frog, the northern DPS of the mountain yellow-legged frog, or the Yosemite toad are known to occur.

Questions regarding whether specific activities would constitute a violation of section 9 of the Act should be directed to the Sacramento Fish and Wildlife Office (see **FOR FURTHER INFORMATION CONTACT**).

Under section 4(d) of the ESA, the Secretary has discretion to issue such regulations as he deems necessary and advisable to provide for the conservation of threatened species. Our implementing regulations (50 CFR 17.31) for threatened wildlife generally incorporate the prohibitions of section 9 of the Act for endangered wildlife, except when a “special rule” promulgated pursuant to section 4(d) of the Act has been issued with respect to a particular threatened species. In such a case, the general prohibitions in 50 CFR 17.31 would not apply to that species, and instead, the special rule would define the specific take prohibitions and exceptions that would apply for that particular threatened species, which we consider necessary and advisable to conserve the species. The Secretary also has the discretion to prohibit by regulation with respect to a threatened species any act prohibited by section 9(a)(1) of the ESA. Exercising this discretion, which has been delegated to the Service by the Secretary, the Service has developed general prohibitions that are appropriate for most threatened species in 50 CFR 17.31 and exceptions to those prohibitions in 50 CFR 17.32. Since we are not promulgating a special section 4(d) rule, all of the section 9 prohibitions, including the “take” prohibitions, will apply to the Yosemite toad.

## **Required Determinations**

*National Environmental Policy Act (42 U.S.C. 4321 et seq.)*

We have determined that environmental assessments and environmental impact statements, as defined under the authority of the National Environmental Policy Act (NEPA; 42 U.S.C. 4321 *et seq.*), need not be prepared in connection with listing a species as an endangered or threatened species under the Endangered Species Act. We published a notice outlining our reasons for this determination in the **Federal Register** on October 25, 1983 (48 FR 49244).

*Government-to-Government Relationship with Tribes*

In accordance with the President's memorandum of April 29, 1994 (Government-to-Government Relations with Native American Tribal Governments; 59 FR 22951), Executive Order 13175 (Consultation and Coordination With Indian Tribal Governments), and the Department of the Interior's manual at 512 DM 2, we readily acknowledge our responsibility to communicate meaningfully with recognized Federal Tribes on a government-to-government basis. In accordance with Secretarial Order 3206 of June 5, 1997 (American Indian Tribal Rights, Federal-Tribal Trust Responsibilities, and the Endangered Species Act), we readily acknowledge our responsibilities to work directly with tribes in developing programs for healthy ecosystems, to acknowledge that tribal lands are not subject to the same controls as Federal public lands, to remain sensitive to Indian culture, and to make information available to tribes.

## **References Cited**

A complete list of references cited in this rulemaking is available on the Internet at <http://www.regulations.gov> and upon request from the Sacramento Fish and Wildlife Office (see **FOR FURTHER INFORMATION CONTACT**).

## **Authors**

The primary authors of this final rule are the staff members of the Sacramento Fish and Wildlife Office.

## **List of Subjects in 50 CFR Part 17**

Endangered and threatened species, Exports, Imports, Reporting and recordkeeping requirements, Transportation.

## **Regulation Promulgation**

Accordingly, we amend part 17, subchapter B of chapter I, title 50 of the Code of Federal Regulations, as follows:

## **PART 17—[AMENDED]**

1. The authority citation for part 17 continues to read as follows:

Authority: 16 U.S.C. 1361–1407; 1531–1544; 4201–4245; unless otherwise noted.

2. Amend § 17.11(h), the List of Endangered and Threatened Wildlife, by revising the entry for "Frog, mountain yellow-legged (southern California DPS)" and adding entries for "Frog, mountain yellow-legged (northern California DPS)", "Frog, Sierra Nevada yellow-legged", and "Toad, Yosemite" to the List of Endangered and Threatened Wildlife in alphabetical order under Amphibians to read as follows:

**§ 17.11 Endangered and threatened wildlife.**

\* \* \* \* \*

(h) \* \* \*

Species		Historic range	Vertebrate population where endangered or threatened	Status	When listed	Critical habitat	Special rules
Common name	Scientific name						

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# Amphibians

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Frog, mountain yellow-legged (northern California DPS)	<i>Rana muscosa</i>	U.S.A. (CA)	U.S.A., northern California	E	834	NA	NA
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Frog, mountain yellow-legged (southern California DPS)	<i>Rana muscosa</i>	U.S.A. (CA)	U.S.A., southern California	E	728	17.95(d)	NA
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Frog, Sierra Nevada yellow-legged	<i>Rana sierrae</i>	U.S.A. (CA, NV)	Entire	E	834	NA	NA
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Toad, Yosemite	<i>Anaxyrus canorus</i>	U.S.A. (CA)	Entire	T	834	NA	NA
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Dated: April 21, 2014

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Daniel M. Ashe

Director, U.S. Fish and Wildlife Service

Billing Code 4310–55

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